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ABSTRACT

This congressional hearing is the fifth of five volumes examining various aspects of agricultural research, extension, and teaching as a prelude to determining what changes are to be made in Title XIV of the farm bill. Focuses are the U.S. Department of Agriculture (USDA) biotechnology program plans and regulatory concerns and the public benefits expected from biotechnology; needs assessment (implications for priority-setting, pesticide use, and technology and farm structure); higher education issues, extension accountability, formula change, and computer technology; and Agricultural Research Service redirections and USDA views on all issues. Testimony includes statements from representatives in Congress and individuals representing the following institutions: Indiana Agricultural Experiment Station; Purdue University; American Institute of Biological Sciences; National Academy of Sciences; National Science Foundation; Michigan State University; Virginia Polytechnic Institute and State University; Texas A&M University; Monsanto Agricultural Products Co.; National Center for Food and Agricultural Policy; University of Kentucky; North Dakota State University; National Agricultural Research and Extension Users Advisory Board; National Association of State Universities and Land-Grant Colleges; North Carolina State University; Maryland Cooperative Extension Service, University of Maryland; University of Connecticut; American Association of State Colleges and Universities and American Association of State Colleges of Agriculture and Renewable Resources; Cornell University; and the USDA. A topic index is appended. (YLB)

LONG-TERM FARM POLICY TO SUCCEED THE AGRICULTURE AND FOOD ACT OF 1981

(Research, Extension, and Teaching)

ED264365

HEARINGS

BEFORE THE

SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND FOREIGN AGRICULTURE

OF THE

COMMITTEE ON AGRICULTURE
HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

SECOND SESSION

JUNE 6, 7, 12, AND 13, 1984

Serial No. 98-70
PART 5

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BIOTECHNOLOGY—USDA PROGRAM PLANS, REGULATORY CONCERNS, AND PUBLIC BENEFITS

WEDNESDAY, JUNE 6, 1984

House of Representatives,
Subcommittee on Department Operations,
Research, and Foreign Agriculture,
Committee on Agriculture,
Washington, DC.

The subcommittee met, pursuant to call, at 1:45 p.m., in room 1302, Longworth House Office Building, Hon. George E. Brown, Jr. (chairman of the subcommittee) presiding.

Present: Representatives Penny, Volkmer, Olin, Roberts, Gunderson, and Evans of Iowa.

Staff Present: Christobal P. Aldrete, special counsel; Peggy L. Pecore, clerk; William A. Stiles, Bernard Brenner, Anita R. Brown, and Gerald R. Jorgensen.

Mr. **Penny** [acting chairman]. The meeting of the Department Operations, Research, and Foreign Agriculture Subcommittee is called to order.

Today we have several witnesses scheduled to testify. At the outset, I want to apologize for the absence of other members of the subcommittee at this time, but there is under consideration on the floor of the House an amendment to the agricultural appropriations bill to add $10 million to the competitive grant program, and of course that grant money would be beneficial to our biotechnology research. As soon as the consideration of that amendment has been completed, we will see several of those members joining us here.

Before I call on our first speaker, I want to insert in the record an opening statement which would have been delivered by the chairman of this subcommittee, the Honorable George Brown of California, and an opening statement from the ranking minority member, Mr. Pat Roberts.

Without objection, those will be entered into the record.

[The prepared statements of Mr. Brown and Mr. Roberts follow:]

OPENING STATEMENT OF THE
HONORABLE GEORGE E. BROWN, CHAIRMAN
SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND
FOREIGN AGRICULTURE
JUNE 6, 1984

Good afternoon. Today we are starting four days of hearings on topics of special interest in research, extension and higher education. I believe this is the first time that all three parts of our public agricultural system have been addressed in one set of hearings. This is the culmination of our 2½ year oversight process for these programs. The knowledge we have gained will be invaluable in making needed changes in Title XIV of the Farm Bill.

These hearings will take a more detailed look at a few program areas of special current interest. Today, we will look at the area of biotechnology. Biotechnology is a broad term encompassing a number of new technologies that allow scientists to understand and alter cellular and genetic processes. Genetic engineering is included in this term. There is widespread consensus that this is a promising research area and that the Federal government should play a leading role. As USDA gears up for an expanded biotechnology competitive grants program, it is timely for Congress to question how USDA can structure the program to fulfill a unique leadership role in biotechnology, as part of its broader leadership role in the food and agricultural sciences mandated by Title XIV. This inquiry should establish that USDA can effectively operate a high quality competitive grants program that will lead to exciting breakthroughs in biotechnology. It is my hope that Congress will recognize the unique need for a substantial USDA program, so that this initiative can build on existing USDA programs. To date the competitive grants program has not exceeded $17 million. Even the $50 million requested by the Administration for 1985 is an insubstantial sum considering the needs.

I am deeply disturbed about the recent action of the House Appropriations Committee on USDA's FY 1985 budget. Although biotechnology competitive grants seem to be increasing by $10 million, which is only one-third of the request, reductions and earmarkings in other categories mean that basic plant science funding will be stagnant. There is also a dangerous trend toward minor earmarkings for competitive grants in the bill. If these actions cannot be reversed, it may be necessary to seek an expansion of the National Science Foundation's biotechnology program. Witnesses at these hearings may offer us guidance on how to proceed.

The Subcommittee has also asked several witnesses today and tomorrow to give us an update on regulatory and judicial obstacles to testing genetically engineered organisms in the environment. The recent court injunction blocking release of the first agricultural organism and EPA's plans to regulate the industry under the uncertain authorities of the Toxic Substances Control Act both point to a possible Congressional role in statutorily establishing a reasonable approval process. This process must protect the public from major risks while allowing the industry to develop. This issue is being raised for the first time before this Subcommittee. More extensive hearings will be needed, perhaps jointly with other Subcommittees, before an optimal solution can be found.

The final biotechnology issue addressed by witnesses today and tomorrow will be the public benefits resulting from the likely breakthroughs in the coming decades. The new biotechnologies will transform the food and fiber system. For the first time, policy officials can anticipate the broad effects of a major new technology. Wise decisions in determining appropriate public roles may help avoid negative societal impacts and ensure a preponderance of public benefits.

We will be hearing from a number of non-USDA witnesses today on these subjects. Some witnesses on subsequent days will also address these issues. On June 13, USDA witnesses will offer views on these biotechnology questions and other issues raised in the hearings.

I now welcome our first witness, Dr. Baumgardt, who will represent the NASULGC Committee on Biotechnology.

STATEMENT OF THE HONORABLE PAT ROBERTS

June 6, 1984

Mr. Chairman, in the next two weeks we will devote four days to examining various aspects of agricultural research, extension and teaching as a further prelude to determining what changes, if any, are to be made in Title XIV of the farm bill. This is an ongoing effort this subcommittee has made over the past two years. We started with extension oversight in February and March, 1982; research oversight in June, 1983; and teaching oversight in February, 1984. Next year we are committed to developing a new farm bill and I assume that a title similar to Title XIV of the 1977 and 1981 farm bills will be made a part of the 1985 farm bill.

Some changes may be needed but so far I have not heard of any concrete proposals for any major changes. As I have often observed, more attention has been paid to ways of increasing funding rather than legislative changes. What this indicates to me is that the major efforts devoted to developing Title XIV in the 1977 farm bill and the correcting amendments in the 1981 farm bill have produced, for the most part, a remarkable framework for getting these all-important tasks accomplished.

There is still plenty of time to give consideration to any needed refinements or changes but time has a way of disappearing when we least expect it, so my advice to all who have an interest is to work among yourselves and with the Agriculture Committee members and staff so that we may develop a reauthorization of

Title XIV that can be included in the 1985 farm bill with a minimum of fuss and fanfare. Certain other aspects of that legislation will prove to be troubling so let us develop this aspect as harmoniously as possible.

Having said this, there are several issues that we will consider in this set of hearings that need to be discussed. I refer particularly to biotechnology and the planning processes. Further we need to determine if we are devoting enough attention to higher education.

With regard to biotechnology there seems to be some conflict as to whether it will do the job as some envision. One comment that I have seen indicates that biotechnology, when the subject matter has been under discussion, can never deliver on all that has been promised. We have a number of expert witnesses to discuss the merits and problems of biotechnology so we should be able to address all aspects.

In the planning process we have made great strides in the last few years of determining our needs and the setting of priorities. Some would say that we have done this before. The question then becomes, was this a paper exercise or can we implement what has been set forth as goals? What can or should the Congress do to assist in this endeavor?

The recent hearing on higher education produced testimony that we were going to be in trouble, if not already so, on the number of students devoting time to agricultural pursuits. This in turn leads to shortages on down the line in available teachers and scientists. What progress can we expect in correcting this situation and again does the authorizing legislation respond to this evident problem?

All of these issues and others must be discussed in the upcoming months so that we are prepared early in 1985 to address the reauthorization of Title XIV. I urge everyone to keep all members of this subcommittee appraised of their concerns and recommendations. By all of us working together we can fashion a product that will assist the research, extension and teaching community in doing their job which in turn benefits the producers and consumers of this nation. Thank you.

Mr. PENNY. The first witness of a long list of expert witnesses today is Dr. Bill Baumgardt, associate dean and director of the experiment station at Purdue University.

Dr. Baumgardt, we call you forward to the table, and let you know that we look forward to your testimony since you have been a leader in the area of biotechnology research, and in particular because of your contributions to what is referred to, as I understand it, the Silver Bullet Study—is that correct?

Mr. BAUMGARDT. That is correct.

Mr. PENNY. Welcome to the subcommittee.

STATEMENT OF BILL R. BAUMGARDT, DIRECTOR, INDIANA AGRICULTURAL EXPERIMENT STATION, AND ASSOCIATE DEAN OF AGRICULTURE, PURDUE UNIVERSITY

Mr. BAUMGARDT. Thank you. It is my pleasure to be here.

As was indicated, I am director of the Indiana Agricultural Experiment Station and also associate dean at Purdue. It is my pleasure at this time to be serving as the president-elect of the American Dairy Science Association and the Agricultural Research Institute, both organizations which are vitally interested in biotechnology. But I do speak here today as a representative of the division of agriculture—NASULGC Committee on Biotechnology, and my comments will be in three categories.

Briefly, I will say a little bit about that committee itself and how it came into being. Second, I would like to address briefly the roles of the private and public sectors; and then primarily I want to talk about the USDA competitive grants program and how it might best be visualized and implemented in fact.

The Committee on Biotechnology, which you referred to as being the author of the "Silver Bullet"—and I will hold that up again for you—we have been assured that all members of the committee do have a copy of each of the two annual reports, and the one that we are referring to here is from November 1983, and I believe each committee member and staff has that in their hands.

The committee, I think, probably has done more study and evaluation of this topic perhaps than any other single group in the country, especially as biotechnology relates to agriculture. I think it is a normal part of the continuing study, evaluation, and development process that comes out of the state agricultural experiment station and the land-grant system. In fact, many of the members of the committee were working on this subject in one capacity or another prior to April 1982 when the committee was formally established.

The committee is continuing to work with several subgroups, and briefly those areas are: the land-grant institutions in biotechnology; the second is education and manpower needs; the third is funding of university-industry relationships; and fourth, national program leadership and development; and finally, social ethical issues related to biotechnology.

Moving to the second topic, after that very brief introduction, to say a bit about public and private roles, since this was mentioned in the charter of this committee in this hearing, I guess what is emerging is obviously a mix of roles and a mixing of sources of funding. In my view—and I think in general—a public sector research program has lead responsibility for much but not all of the basic research for educating and training of students, for ensuring application to a wide variety of the needed agricultural plants and animals, in this case.

On the other hand, I see that certainly the private sector has a responsibility for much but perhaps not all of the applied research and development, but they also have to have access to basic research findings at an early time. And, for that reason, among others, many of the private institutions and organizations have established very sizable in-house basic research programs of their own. These organizations, and many other of the private sector, of course, also, support research in the public sector.

One point I would like to make here is that while much of the research arrangements with industry in the past and up to the present represents a 1-to-1 relationship, one company and one university, I do perceive an expanding role of what I would call a consortia concept whereby several companies may join together and support research of a fairly basic nature at one or perhaps several universities, and then share in the early window on that technology as well as sharing in the scientists that are being trained through that process.

I would add, and want to stress, however, that I believe it is in the public interest, the public's best interest, that much of the basic research be done in the public sector and be funded by the public sector. I believe that to be true for several reasons, one of which is that I think many of the most fundamental discoveries are best done that way, made public, so that they can be appropriately exploited by scientists in all areas, whether public or private. And, second, I think it is appropriate that scientists be trained in this public arena and with the public funds.

Now, the base support for the public funding of biotechnology research of course coincides with the State and the Federal Government. The State agricultural experiment stations, again, I think, represent a good example of how this can and should work. Experiment stations, of course, established and funded through the Hatch Act, is truly a Federal-State partnership and the States are carrying a very major load of that program.

For example, in 1981, for every $1 the States received for agriculture research from the Federal Hatch funds, they put in $4.69 of their own State money. This base program has many advantages in terms of providing that continuity and enabling long-term research to be done and providing the array of disciplines necessary to attack a field such as biotechnology.

Our committee, the Biotechnology Committee of Land Grant Associations, surveyed the State agricultural experiment stations to determine what the size and scope and nature was of present activity in biotechnology, and I am pleased to report to you in the published report also that there are 579 projects underway at the present time just in the State agricultural experiment stations on biotechnology involving 283 full-time equivalents of faculty, and actually that is 650 faculty people working on it; in other words, 650 minds devoted to this study.

A total activity at the present time in the agricultural experiment stations across the country are $40 million.

In addition, we surveyed, with the help of USDA, the effort underway now in ARS, and learned that 94 projects in biotechnology are currently active in ARS, and that involves 78 full-time equivalents of scientists.

Another survey is being made by the committee at the present time to get it similar information on all of the rest of the community within the Land Grant Association, and we hope to have that available later this year.

Our committee has done other things to help foster appropriate private and public funding relationships, such as issuing draft statements on tax considerations, patents, guidelines for industry-university contracts, faculty consulting, and this type of thing. But overall, I think our committee has been active in terms of raising issues, attempting to address the important ones and to seek some leadership role in bringing about solutions.

Finally, then, I would like to spend the remaining time on the structure of the USDA grants program. The committee has proposed a program, as I suspect you are aware of and are very supportive of—what has come out as the USDA program. I think they are very compatible. We approach this in the Biotechnology Committee from the point of view of surveying and analyzing what effort was underway, what scientist power existed now, and where the greatest impacts could be made if additional funds were made available. We looked at the needs for equipment for students to be trained and then developed a grants program that we felt would help meet those needs.

I would want to emphasize that the key issue we kept in mind in putting together a concept of such a program was that it must excite the kinds of cutting edge science that can be brought to bear on the most significant biological problems facing agriculture. We need the best minds to work on this important problem.

The program, as visualized by the Biotechnology Committee, which we outlined in this report, called for a program of $70 million. That would have had $24 million in individual research grants, $16 million in multidisciplinary research grants, $1 million for young investigator awards, and $5 million for post-doctoral and senior post-doctoral fellowships, and $24 million for equipment grants for that total of $70 million.

Some questions have been asked: Could the system effectively absorb that $70 million? And we feel in all honesty this is a minimum really to make the kind of impact that can be capitalized on at the present time. Just one way of looking at that is to indicate that if this program would be utilized only by scientists in biotechnology in the State agricultural experiment stations, which is not correct, there would be a much wider audience; but if that were the case, only 23 percent of those scientists would have the opportunity to be recipients of funds. So the capacity is there to effectively utilize a program of the $70 million-plus magnitude.

We stress that for the program to have the desired impact it must be added to base funding. It cannot replace existing kinds of funding. I have already spoken to why that base funding of Hatch and State and other existing public funds are so important. We also spoke under the operations of such a program that it should be open to all scientists so that we can, in fact, bring the best minds to bear on important agriculture problems. It must have peer review panels, a proper program counsel, and other details to make it a strong science effort.

Some specific questions have been raised apparently about some subsets of the program, and that one of those was related to: Is there a need, or what is the need for multidisciplinary grants programs? And I know that a speaker later in the session will make reference in some detail about the McKnight Foundation proposals, and I would simply want to say that our committee endorsed that concept, and that is what we had in mind in terms of the multidisciplinary research proposals.

I would hasten to add that sometimes we get misled by thinking that an individual research proposal means only one scientist. More often than not, an individual research grant does have several scientists working on it, although there is one PI, or principal investigator. So don't be misled by thinking that an individual grant does mean you are supporting the work necessarily of just one scientist. There may well be several receiving funds in that way.

But certainly the field of biotechnology is complex. It is an ideal place to have an enlarged effort for a multidisciplinary effort, and we would strongly endorse that in the program.

Another question has been asked about the size and the short-term nature of competitive grants. Let me simply state that we believe it is important that these grants be funded at an appropriate level per award so that significant findings can be made, and that level, in case of an individual research grant, we think should be in the area of $100,000 to $125,000 per year for that grant. This would allow some meaningful research to be done.

Now, we understand and grant that many of the current programs are being funded at levels less than that, apparently on the decision that it was better to get some money to more scientists than to get adequate funds to fewer scientists. I do not wish at all to discuss or debate the wisdom of existing programs. We would, however, argue for this program that this level be maintained insofar as possible; that is, that significant levels of funding be made in the area of $100,000 to $125,000 for individual grants, and at least

$200,000 for a multidisciplinary grant so that the right teams can really be brought together and get the job done.

In that vein, I would like to add I think it is very important that the $50 million cap that currently exists in the competitive grants program, title XIV of the farm bill, be removed in the revision that will be coming up soon. We would urge the committee's attention to that particular trade.

Mr. **Penny**. Dr. Baumgardt, if you don't mind yielding for a few minutes, I need to go and record my presence and then vote on the Brown amendment to add $10 million to competitive grants.

Mr. **Baumgardt**. Please do.

Mr. **Penny**. I will rush back, and hopefully I can bring a few of my colleagues with me.

Thank you.

[Recess taken.]

Mr. **Penny**. Here we go again. Let's give it another try.

I have some news about what just happened. We were supposed to get over there for a notice quorum. Pending that, they had a standing vote on whether to take up this amendment. That vote was not successful so I don't know what Mr. Brown is going to do at this point. But he told me to come back and keep things rolling here. And we may or may not get another shot at that amendment later.

Please proceed. I think you are somewhere on page 9.

Mr. **Baumgardt**. My next point is that the question has been raised for linkages between what we might call the traditional sciences like plant breeding and genetics and molecular biology. We want to assure the committee that this linkage is already well underway in many parts of the system. It is one of the examples of the agricultural experiment station. Plus, it also provides the linkage for technology transfer via the cooperative extension service.

Furthermore, we want to assure the committee that the proposal as viewed by our Biotechnology Committee recognizes the need for this type of linkage, and we feel this would be one very appropriate place for use of some of the multidisciplinary research grant efforts.

So, finally, then I would like to present my views and the views that I believe are also of the committee on how the 1985 biotechnology increase could be most effectively utilized, and I am doing this: I am sticking with, if you will, the figure of $28.5 million. I think that is the only realistic thing we can do at this time, and I think that is a minimum figure, and I feel quite comfortable in speaking in those terms.

Given that reduced level of funding from $70 million, which we assume was a realistic, modest level to the executive budget request of $28.5 million, we would recommend that emphasis be placed on the research grants categories. Furthermore, we would recommend that the individual and multidisciplinary grants both be funded, and perhaps something in the area of the same ratio as proposed, which was a 60-40 type of split, and that could allow, for example, for about $17 million in individual research grants, or, let's say, 150—at $100,000 per year each, plus some equipment, and could allow $11½ million for the multidisciplinary research grants, which perhaps could fund 50 of those at $200,000 per year.

We realize, of course, that that does not directly address the very important infrastructure needs of the system; that is, the training of graduate students and the supplying of equipment which is so costly in this area. However, we would urge that special attention be given to encouraging graduate student participation in these research grant programs. After all, actually having a graduate student work on a real research grant is the best way of providing training to that student, anyway. So we would encourage their participation in these programs.

Also, we would encourage allowing some funds to be kept perhaps aside at the start to fund some equipment in the regular research grant category, making sure that certain grants to acquire a piece of equipment at some particular level can be adjusted or taken care of.

Beyond those adjustments, we would recommend implementation basically in accord with the carefully developed scientifically sound proposal that we think we originally made. And, in summary fashion, that is, first of all, program areas to establish a thorough understanding of the genetics, biochemistry, physiology, metabolic control, and developmental biology of plants, animals, and microbes to provide the basic scientific knowledge needed for the development and application of the new biotechnology in agriculture.

Second, in both areas of individual and multidisciplinary research grants, we would stress those areas where there is the greatest need and where the best ideas for advancement come forth. Initially, it should focus on how genes work, how they can be beneficially manipulated for the benefit of agriculture in those crops and animals that are most needed and useful there.

The program should have a strong mission orientation in that regard, in other words, of targeted basic research. A group of leading scientists should be brought in to lay out the specific criteria for these areas, to point both the areas of greatest need and also the areas which they feel are ripe for picking, if I may put it that way; in other words, areas that are ready to capitalize on and make some great strides forward. It is very important, in our view, to keep the scientists involved in designing the final program.

Operational procedures should include, first of all, grants that would be investigator-initiated, peer reviewed, and awarded on a competitive merit basis. Second, the program should cover the basic principles utilizing plants and animals and microbial systems; and the program should be open to all scientists in public and private universities, experiment stations, research institutes, and governmental laboratories.

I do thank you for the interest on the part of this committee in this very significant program. We believe that with the foundation which would be laid by this enlightened program, we would have within our power the capacity to ensure the leadership of the American agricultural and food system and the security of the world's food supply.

That completes my prepared statement, and I would be pleased to respond to some questions, if you would have them.

[The prepared statement of Mr. Baumgardt appears at the conclusion of the hearing.]

Mr. **Penny**. Thank you, Dr. Baumgardt, for your testimony.

Earlier in your remarks you mentioned consortia agreements. Can you give some examples of companies and universities involved in those types of arrangements?

Mr. **Baumgardt**. I would say that most examples to the present time are really in fields other than biotechnology. I would stand to be corrected on that by some later person that appears here this afternoon. But there are many examples from the engineering and electronics field, and many of these have had their start at least, or some of them have had their start, through the NSF sponsored university-industry research program which has been a system whereby NSF would help get the system going, would provide some research funds for a period of time, and then industries would be picking up the funding over that period of time. So after, say, 5 years, the program would no longer have NSF funding but would have industry funding going along with the base funding support from that institution.

But, again, the concept in these cases—specifics vary, but the concept is that it is a group of companies who have an advisory committee who have input into exactly what research will be funded year by year. They have access to a rapid window on that technology. They may or may not participate in licensing arrangements of things that might come out of the program and be patentable and licenseable, but they do participate in the program and in the early access to the findings.

Some of our conversations would indicate that in the area of biotechnology there is potential for this type of a thing to occur, and, for that matter, I think many of the companies believe it should be a basic research-oriented type of thrust. And I don't really visualize that the ownership patentable licensing kinds of issues would be significant in a properly constructed university-industry consortium.

Mr. **Penny**. You also mentioned in your testimony several States—or you mentioned that several States were beginning to set aside moneys for this kind of research.

Can you give some examples of States and what kinds of dollars they are obligating?

Mr. **Baumgardt**. Yes, sir. I really had hoped to be able to do a bit of a survey, and I guess I would have to say that time did run out. But I know, for example, without figures at my fingertips, that North Carolina and New York have programs going at the present time.

I am aware, for example, in Oklahoma that the Governor proposed start-up funds of a $15 million level to be matched by private industry to build facilities and to equip programs in the biotechnology area, and I think they now have something like $13 million committed from the private sector to go along with that.

California, I understand, has $40 million for high tech research last year in this area at the University of California at Davis.

Texas A&M University, in fiscal year 1984, began a new continuing program I believe of about $1.6 million for the systemwide agricultural experiment station biotechnology research; and they also are actively working to leverage that with individual industry research grants.

The Florida legislature has made an appropriation for this area. In my own State of Indiana, we are still working with that process.

But I was interested and noticed as I was coming in yesterday, in the USA Today paper there was a cover story on "States Helped Build Firm, Strong Base," and they did make reference in that article to one of the State structures that has been put in place; namely, the Corporation for Science and Technology, and this is now a private operation but with State funds to help get this very kind of thing started.

We have a proposal in for $1.5 million for biotechnology research and agriculture, and that has passed the first two hurdles and has one hurdle remaining. So, again, I think these kinds of efforts have been stimulated or have been speeded up by the attempts to really focus on the issue and get the word out on what the opportunities are.

Mr. **Penny**. When you mentioned just a few minutes ago about money being made available to start the necessary research but then being picked up and carried on in the private sector, is that the kind of thing you were calling a spike thrust? Or were you talking simply about the initial money helping a public institution get the program started and then finding its own way to keep it alive within that public institution?

Mr. **Baumgardt**. I was speaking there of, for example, the NSF university-industry research program, and I think that type of funding which would come in until the industries picked it up was really the carrot to help encourage the industries to get involved to do their part.

Again, I would backup and say that I visualize the total thrust, the total funding mix, even in the public university sector, that funding mix should include State funding, should include Federal funding, and should include private industry funding. It takes all three.

So, in the one case, I was saying that maybe even to get some of the private industry funding, this would be fostered by having that started by a Federal agency and then over time industry comes in and does what I am saying is their part, but that is apart, separate from a continuing leg on the three-legged stool that must be met by Federal competitive grants funding, or the more basic research parts of it.

Mr. **Penny**. What do you see as the effect of the injunction banning release of genetically engineered life forms?

Mr. **Baumgardt**. First of all, I would say we are all very concerned and interested in quality science being done, in safety being assured, and those things. Therefore, we most certainly do not take it lightly. We think it is important that the system be thoroughly evaluated in light of all the testimony and the things that have been brought forward.

However, to address your question specifically, there is no doubt in my mind whatsoever that if a process is not arrived at that will enable research to move forward, that this field of science in the United States will be very seriously impacted and will be held back, and there will be problems of moving forward with much of the essential research that should be done.

But, again, I would emphasize we certainly want to do that research in the appropriate kinds of restraints and situations. We want to make sure we are doing it in a correct and safe way. I have confidence that the scientific community can do that, and I would hope that the efforts in that direction can be kept within science-oriented agencies.

Mr. **Penny**. Do you think—and this is one last question on a different aspect of this whole issue—do you think there is some risk that we could find just a few private sector companies dominating the biotechnology developments?

First of all, if you feel that that is a risk, tell me how you think we can help avoid that through our public policy in this area?

Mr. **Baumgardt**. I think that industry is attracted, by and large, to where the good science is, where the good science is taking place. Therefore, a competitive grants program of the type that we are talking about would help ensure the broader coverage of industry participation and would also help keep more companies involved by being able to make contacts with different universities.

So I think the Federal funding enhancement and enlargement would, in fact, help to involve more companies, because each of them do work out some arrangements with a university, and I think it is a partnership that will, in the end, yield the greatest benefits for all.

I would really be reluctant to speculate as to how many companies of what size may finally come out, but I do not think it is going to be a small field. I think there will be a significant number of companies of modest size. There will be a few giants, no doubt, as there are now, and will continue to be.

Mr. **Penny**. Dr. Baumgardt, I really appreciate your testimony and your responses to my questions.

If there are other questions by members, as they arrive we may call you back or we may submit those questions to you for your response.

But thank you again for being here.

Next I would like to call on Dr. Robert Rabin, Acting Assistant Director, Biological, Behavioral, and Social Sciences at the National Science Foundation.

Dr. Rabin, thank you for joining us today. Your entire testimony will be submitted in the record, and you may proceed.

STATEMENT OF ROBERT RABIN, ACTING ASSISTANT DIRECTOR, BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES, NATIONAL SCIENCE FOUNDATION

Mr. **Rabin**. Thank you, Mr. Chairman.

My name is Robert Rabin, Acting Assistant Director for Biological, Behavioral, and Social Sciences at the National Science Foundation, and I am appearing at the request of Dr. Edward A. Knapp, Director of the Foundation, in response to your invitation to testify at this hearing.

This is an opportunity to introduce Dr. David T. Kingsbury, who is sitting behind me, and he is the President's nominee for Assistant Director, Biological, Behavioral, and Social Sciences at NSF. Dr. Kingsbury is professor of medical microbiology and virology at the School of Public Health, University of California, Berkeley. Also, he is scientific director, Naval Biosciences Laboratory, at the university. Upon his assumption of the Assistant Directorship at NSF, I will resume my duties as Deputy Assistant Director for BBS.

This subcommittee has performed an outstanding service by conducting extensive hearings since 1982 on critical issues in agricultural science and education. The National Science Foundation and the National Science Board have been pleased to participate in your efforts.

I am particularly pleased also to acknowledge the cooperation between the USDA and NSF. It is strong, constant, and productive. It has included participation in domestic and international interagency committees, joint planning and funding of research, and joint participation in symposia, review panels, and publications.

Cooperation between our agencies began as early as 1951, soon after NSF was established. At that time, S.B. Fracker, Assistant to the Administrator of the Agricultural Research Service, asked Alan Waterman, NSF's Director, if it would be appropriate for USDA to send research proposals on photosynthesis to NSF to be reviewed and considered for funding. Dr. Waterman welcomed this chance; interactions between staff that began shortly thereafter started a long, fruitful relationship that was to increase considerably.

In 1976, NSF played a major role in helping USDA set up its competitive research grants program, and both agencies continue to work together to ensure the success of this relatively new USDA program.

I believe this more recent history has been reviewed by this subcommittee and by the House Science and Technology Committee during Dr. Eloise Clark's tenure as Assistant Director of NSF. It is fitting to close my remarks on this aspect by reminding the subcommittee that Dr. Wendell L. Roelofs was awarded the 1982 Wolf Prize in agriculture for his work on pheromones and their practical use in insect control. Dr. Roelofs' research was supported by NSF.

Mr. Chairman, let me turn to a central issue of these hearings: biotechnology. You will recall the testimony of Dr. Charles E. Hess last February 7 before this subcommittee when he appeared as a member of the National Science Board. He spoke strongly in support of the new biotechnology initiative proposed in the fiscal year 1985 budget for USDA. He was reflecting both his personal and NSF's concerns for the welfare of this initiative in its journey through the congressional budget hearings.

I should apprise you of events since then in which Dr. Hess has figured. In late February, the National Science Board agreed to dedicate a substantial part of its June meeting to a discussion of biotechnology. It appointed Dr. Hess to lead a task group of the Board in developing the issues and background papers. I have been privileged, in leading NSF's staff in support of this effort, to work closely with Dr. Hess.

Also, the Board recently elected him as its Vice Chairman. I believe that these actions will have a salutary effect in continuing what has been a mutually advantageous relationship between NSF and the USDA.

The Board's deliberation on biotechnology will center on several topics: One, its relevance to our national interests; two, the major national needs to support biotechnology; three, the role of the Federal Government, particularly in basic and applied research; and four, specifically, NSF's role both current and future. The Board's discussion with us and their recommendations will have a very useful influence in shaping the Foundation's policies and activities.

Mr. Chairman, biotechnology is not a new human activity, and it is not the province of a single Federal agency. Mankind has employed it to ferment grain to produce industrial alcohol, to make bread, to create vaccines, and to produce penicillin. These are examples of what is called old biotechnology.

New biotechnology, however, is the child of Federal research support mainly in our colleges and universities. It continues to be nurtured by the funds from NSF and agencies whose missions are rooted in public health, agriculture and energy, and to a much lesser extent, defense. The faith of the Congress in dedicating substantial funding for research from the early 1950's onward is being rewarded and reinforced by the frequency of results and the promising potential for increased national industrial economic growth.

New biotechnology comprises three primary groups of technologies: recombinant DNA technology, cell fusion technology, which includes hybridoma technology and somatic cell genetics, and bioprocess engineering. The application of these to agriculture is in its infancy, but their use has been enticingly referred to in the recent report to the Congress by Secretary John R. Block with which you are familiar: "Needs Assessment for the Food and Agricultural Sciences."

Historically, NSF has provided financial support to the study in plant and animal systems of fundamental genetics, cell physiology, cell culture biology, nucleic acid chemistry, biochemical engineering, and microbial process engineering. Findings from these areas have provided the bases for the exciting technologies of today.

One of the most valuable applications of biotechnology that also receives support is the use of gene splicing, cell fusion and bioprocess engineering methods as tools in research projects themselves. They are often critical to experiments in biology, chemistry and engineering.

This last point deserves emphasis: Simply having a collection of techniques utilizing the manipulation of DNA or the fusion of cells does not constitute an established technology which requires only an occasional fine-tuning. Deficiencies in our knowledge impede the continued developments of these techniques for use in basic science and their ultimate commercial application.

Thus, in providing a powerful set of tools for biological research, biotechnology has accelerated scientific discovery in areas where the commercial application of the technology itself is not immediately obvious. The traditional role of NSF in the support of basic research has been to encourage new ideas and approaches proposed by the scientific community. Generally, regard for their applicability to a practical commercial problem has been of secondary importance.

It was because the community that NSF serves saw great opportunities in the plant sciences—to better understand structure and function at the molecular level with "new biotechnology" and sophisticated instrumentation—that we embarked on a substantial effort to convince the board, our management, the administration and the Congress to increase our ability to support this work. Acting on its conviction that plant science could benefit from the remarkable advances in molecular biology evident from studies of viruses, bacteria and animal cells, the board recommended and management agreed to substantial increases in the Foundation's budget. Between fiscal year 1983 and the request for fiscal year 1985, the budget has increased 36 percent for research in plant science.

Mr. Chairman, if the Congress appropriates fiscal year 1985 funds for NSF's use in the plant sciences at the administration's requested level, we estimate that we will obligate $58 million next year. This is a 70-percent increase over the funding in fiscal year 1981 which was $34 million. But not all of this increase is allocated to plant molecular biology. About 43 percent, or $25 million, will support research in ecology, systematic biology, population biology and ecosystem studies.

Last year, the Foundation held its first competition for postdoctoral fellowships in plant biology. The new program was inaugurated to enhance broad interdisciplinary approaches to plant research. It responded to the need, (1) to catalyze more extensive use in plant research of the techniques developed in research with microbial and animal systems, and (2) to provide support for young scientists in these most promising areas of research in which the demand for scientists is increasing.

In 1983, fellowships were awarded to 24 young scientists who had earned the doctorate degree after January 1, 1980. These were selected from 194 applicants. The new fellows included 14 women. In 1984, in the competition recently concluded, 20 fellows, including 5 women, were selected from 128 applicants.

The fellowships are for 1 year and are renewable for an additional year. Each fellow is free to select an American or foreign institution for further study. Among the 44 fellows selected, only 8 chose to work abroad; and of the latter, 5 elected to study at the superb national plant laboratories in Australia. Plant genetics has been the most popular field of study among the disciplines in physiology, cellular and molecular biology.

Now I would like to briefly note some findings of a survey sponsored by NSF. It was conducted by the Higher Education Panel of the American Council on Education. The conclusions are preliminary and may be revised later. Last autumn, 210 doctorate-granting institutions were questioned about plant science programs, and remarkably 90 percent responded. 165 reported graduate programs in plant biology.

These institutions received about $200 million in research support. Half came from the Federal Government; 34 percent came from State governments. Industrial sources provided only 10 percent.

Approximately 8,000 graduate students were accounted for in the survey. Federal research grants supported only 20 percent of them, and only 3 percent had Federal fellowships. State governments supported 12 percent; foreign governments supported 10 percent; and industry's contribution was 7 percent. The institutions themselves supported 30 percent of the students.

For the 1,000 postdoctoral students, the Federal support picture is considerably different. Federal research grants supported 54 percent, while institutional support in this group shrank to only 7 percent, the same figure for State governments and industry. Federal fellowships accounted for 6 percent, and foreign governments 12 percent of the total support of this population.

The graduate programs are attracting many women. They comprise 30 percent of the full-time graduate students, post-doctorals, and research associates. About 20 percent of doctorate degree recipients were women.

The United States is training substantial numbers of foreign students. About 1,600, 20 percent, of the full-time graduate students, and about 330, 33 percent, of the postdoctorals hold temporary visas. Of the 1,600 foreign graduate students, 1,200 are from developing countries, as are 130 of the 330 postdocs.

The land grant institutions dominate the graduate programs in plant biology. They account for 80 percent of the research funding, 80 percent of the faculty, 80 percent of the graduate students, 80 percent of the Ph.D. recipients, and 70 percent of the postdoctorate scholars.

Finally, this survey revealed that the disciplines of plant molecular biology, biochemistry, and genetics were those most cited as having a shortage of personnel in postdoctoral training positions, permanent research associate positions at the Ph.D. level, and in tenure-track faculty positions. Data from the surveyed institutions also agreed with other data collected by the Congressional Office of Technology Assessment and the National Research Council: Industrial positions in plant molecular biology, biochemistry, and genetics are in greatest demand.

These findings have policy implications for individual agencies and for Federal sponsorship of research and training generally. As for NSF, I would note that the budgetary growth which I mentioned is a recent event. The discoveries of the 1970's that make up the new biotechnology were possible because the United States in the 1950s and 1960s chose to build world leadership for itself in the life sciences.

From 1968 to 1982, Federal funding for nondefense research in real dollars shrank. This administration realized that we can't live off past investments so long without renewing them, and has emphasized plant biology.

The heart of our program is the single principal investigator-funded research project. In fiscal year 1983, grants from NSF's biology programs averaged $20,000 per year in constant 1972 dollars. Each grant included both total direct and indirect costs. Only in the past 2 years has the attitude changed; modern biology can no longer be viewed as a cottage industry. It is unreasonable to think that U.S. leadership can be maintained without increasing substantially our investment per award. I have the same opinion about the USDA's competitive grants program.

The survey by the American Council on Education indicates that industry's support of plant science research in academe is 10 percent of the total, or about $20 million. Industry supports 7 percent of the graduate students and about the same percentage of postdocs. Industry, at least presently, clearly expects the Federal Government to be the chief patron of research and training.

The data confirm what I have heard privately from industrial R&D officials. Yet, industry will continue to be a major beneficiary of the Federal investment. If land grant universities remain dominant in plant science graduate programs, and if the need in both academe and industry is chiefly for people trained in the "new biotechnology," it seems obvious to me that the Federal financial responsibility must be better balanced among the agencies.

In 1984, NSF's budget of $33 million, the USDA's budget of $15 million, and the Department of Energy's budget of $11 million for competitive research grants for modern molecular studies of plants totals $59 million. NSF accounts for 56 percent of this.

Since NSF doesn't focus its efforts on agricultural research, we really need, as Dr. Keyworth, the President's Science Adviser, has said: ". . . a substantial program of complementary research within USDA." Given this, I believe that in the future we can realize what new biotechnology promises for agriculture: improved veterinary vaccines, plants that thrive in arid or salty soils, pest- and infection-resistant plants, and crops that can fix nitrogen from the air.

Thank you. I will be pleased to answer your questions.

[The prepared statement of Mr. Rabin appears at the conclusion of the hearing.]

Mr. Penny. Thank you, Dr. Rabin.

You indicated earlier in your testimony that you did not treat commercial applications as the primary consideration in deciding which research to pursue.

Is there any consideration given to the high cost research areas that are unlikely to be undertaken in the private sector if the Government doesn't in fact do those?

Mr. Rabin. I would appreciate it if you would indicate to me what you mean by the high cost areas.

Mr. Penny. Maybe I shouldn't say high cost areas, but areas that maybe aren't viewed by the private sector as having a big payoff once the research is done. Increasing seed proteins is an example.

Mr. Rabin. And your question is, do we consider those possibilities in our priorities?

Mr. Penny. Yes, sir.

Mr. Rabin. The primary driving force is the quality and the excellence of the science. It has been for 34 years of the Foundation's history, and continues to be. In the peer review process, judgement rests first on the quality of the science proposed. When I speak of this, I speak primarily, sir, of the research directorates that sponsor basic or fundamental research.

There are other units or programs—and I think Bill Baumgardt mentioned that earlier—of the Foundation to deal with the industry-university cooperative research centers and industry-university cooperative research grants. Some of those activities undertaken in those areas are, indeed, valued by and examined by committees of industrial scientists working together with the academic scientists, and those that are undertaken very often have that joint review behind their sponsorship.

But if it is primarily Federal support, then I must admit that our first goal is the quality of the science.

Mr. **Penny**. I was also interested in the statistics on the kinds of students we have in our graduate programs. You had, I think, a statistic of 1,600 foreign students; is that right?

Mr. **Rabin**. 1,600, yes, full-time graduate students are foreign; that is right.

Mr. **Penny**. In all of this, you didn't give an interpretation of what these statistics mean, especially with that number of foreign students involved.

Where are they going and what are our expectations of that foreign student population?

Mr. **Rabin**. Since I am not an academician, I would attempt only an opinion for this particular question. My feeling is that the expectation would be both on the part of the sender and the part of the receiver countries that the students would probably return to their home bases. Obviously, from past experience we know that some percentage of them would like strongly to remain in this country, and may indeed find positions of employment in this country for longer periods of time beyond their training.

What heartens me—although I don't know if it is an interpretation, but an opinion again—what heartens me is that 1,200 of the 1,600 foreign graduate students are from developing countries. I feel that there is a stronger sense of obligation on the part of the sending country, therefore, to expect the return of those students well trained and to be able to take the training and apply it to the country's needs.

I also feel that having had the opportunity to study in the United States gives those 1,600 an excellent relationship with U.S. scientists across oceans, countries' borders, and so forth, to continue that which their studies in this country originally provided them.

Mr. **Penny**. Thank you. I don't have any further questions, but I would call on the chairman of this subcommittee.

The chairman has indicated to yield to the ranking minority member, Mr. Roberts, for any questions he might have, first.

Mr. **Roberts**. I thank the chairman, and I apologize to my Chairman and my colleague for my late arrival to the subcommittee's hearing.

But I want to welcome Dr. Rabin and thank you and the other witnesses for your very good testimony. I have no questions at this point.

Mr. **Penny**. Mr. Chairman.

Mr. **Brown**. Thank you very much.

Dr. Rabin, I have been impressed by your testimony. I think it gives a good picture of a responsible response to an area of big scientific problems as far as the NSF is concerned. I, too, was impressed by the figures that you gave on the number of foreign graduate students in this area.

I wonder, do you happen to recall any further breakdown amongst those in Third World countries as to where they might be coming from?

Mr. **Rabin**. I don't think those data are available. If we have them, there will be some later, but I don't think we went that far on a country-by-country basis.

Mr. **Brown**. I had the experience of traveling in India in December, talking to some of these American-trained agricultural scientists who had returned to India. Generally speaking, they all raised the same sort of problem: Most of the underdeveloped countries including India did not really have the capability to fully utilize, to provide the research facilities and other things that these scientists really should have to be of most benefit to their country. Which indicates to me the possibility that we ought to strengthen our programs of helping them build their scienitfic infrastructure as well as providing the training for them.

I wonder if you would comment on that.

Mr. **Rabin**. I agree with your assessment. I think it is a matter of a national Federal commitment both at the administration level and the congressional level to deal with this as a philosophical question. To what extent should the United States extend beyond its borders that capacity to train foreign students, bring them in, and offer them the place to go back to which would be most receptive for them.

I think you are absolutely right in the sense that in Europe and in the United States, the infrastructural capacity to serve scientists is very strong. Supplies, instrumentation, and equipment are in place. The capacity of this Nation to respond to the needs of the research community is not duplicated anywhere else.

Largely, then, is a matter of not only training your students but to what end. How we debate or deal with the issue of to what degree we should go in service to foreign nations, in helping them to set up an infrastructure capable of receiving the students we train is a very difficult matter.

I think if I said anything, it would be shooting off the top of my head without really an adequate understanding of what you have already visited and understand far better than I.

Mr. **Brown**. I don't want to belabor this, but the real thing that I am interested in is why in both absolute numbers and percentages we have this preponderance of people from the Third World showing a deep interest in this relatively recent emerging field of research. Is it possible that they are better informed about its significance in the development of their agriculture, which in most of these is most of their economy, than we are in this country?

Mr. **Rabin**. I think that is probably true. I think it is a question that their interests and their individual capacities to produce agricultural products, considerably influence their economies and thus their need for highly trained specialists.

This is a huge country. We have tended to see the shift to what I call new biotechnology as an evolutionary process. To foreign students coming over and expecting the capacity of this new knowledge to be translated into new products, whether of agricultural or pharmaceutical nature or what have you, probably represents a tremendous hope on their parts, and I think that that is about all I can say about it. Whether it is realistic or not is another question entirely.

Mr. **Brown**. We have just gone through the exercise this afternoon of trying to get the House to look more favorably upon the full funding of the administration's request for biotechnology. The bad news is that we didn't succeed in increasing the funding. The good news is that at least half the members of the Appropriations Subcommittee dealing with this told me that they thought that we were right in this regard, and that when they went to conference with the Senate, that they would be much more favorably inclined, but there is a reluctance here to overturn your chairman's well-set views on some subjects.

We were not able to prevail, but I am relatively hopeful that the final result will be close to what the administration requested. Now, this is still a relatively modest sum, less than the Foundation is providing this year. The criticism that the chairman made that this is too rapid an expansion of a program, even if it were very valuable, leads me to ask you the question. You have given some figures on how rapidly NSF has moved ahead in this area in a relatively short time. I think you said a 70 percent increase in 3 years?

Mr. **Rabin**. Four years.

Mr. **Brown**. Four years. What can you tell us of your plans for the next 2 or 3 years? Do you feel you have leveled off or are you still on a curve, or what is your estimate?

Mr. **Rabin**. I will devote all energy at my disposal to see that that increase at the same rate or better goes on.

Mr. **Brown**. That is encouraging. If we could break the logjam in the Department of Agriculture, it would be doubly encouraging for our future progress in this field.

I thank you very much for your testimony.

Mr. **Roberts**. I would just simply make the observation on behalf of my chairman, when he went up against the streamroller on the floor of the House a few short minutes ago, like the famous bird, the phoenix, he will rise again to fight another day. I think that message is well accepted by the people. He fought the good fight.

Mr. **Brown**. Thank you, Dr. Rabin. We appreciate your testimony.

The next witness is Dr. Ralph Hardy, Member of the Board on Agriculture, National Research Council, National Academy of Sciences and Director of Life Sciences Research at Du Pont. Doctor, welcome to our subcommittee.

STATEMENT OF RALPH W.F. HARDY, MEMBER OF EXECUTIVE COMMITTEE, BOARD ON AGRICULTURE, NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES

Mr. **Hardy**. I am Ralph Hardy, here as a member of the National Research Council's Board on Agriculture, a member of Cogene, the Committee on Genetic Experimentation, which is a committee of the International Council of Scientific Unions that deals with the genetic area. I am also currently an employee of E.I. du Pont.

I appreciate the opportunity to comment on the U.S. agricultural research and technology area. I am especially delighted at this time, because I think we are poised at one of the most exciting opportunities that has existed in agriculture for probably the last 50 years. Some of my friends have commented that we are looking at an opportunity not unlike the vitamin nutrition era of the 1930s.

What I would like to do is briefly comment on the activities of the Board on Agriculture, comment on the challenges as we at the Board on Agriculture see U.S. agriculture facing in a dramatically changing world, and then to speak to some of the roles that science and technology can play, in enabling U.S. agriculture to cope with this changing world.

The Board on Agriculture is one of the eight major program units of the National Research Council which functions under the National Academy of Sciences, National Academy of Engineering and Institute of Medicine, and addresses issues in plant and animal sciences and renewable resources. It provides advice and guidance on science and policy questions at the request of Federal agencies, and also at the initiation of the board itself.

Examples of some of our current activities include a review at the request of USDA of their biosciences activities in ARS. The specific objective of this review is to identify areas that will pay highest dividends in terms of the new biotechnologies in agriculture.

We also are looking at the new biotechnologies in agriculture to provide a national strategy for biotechnology in agriculture. We have another group that is looking at the competency needs in agricultural research, and another group that is looking at strategies for the management of pesticide-resistant populations. There are other programs as well being looked at for possible initiation at this time.

Let me now comment on the challenges of U.S. agriculture in a dramatically changing environment. I think the environment of agriculture worldwide is changing more dramatically than at any time heretofore. These are partly national changes, they are partly international changes. There are aspects such as consumers who will continue to expect low-cost food, but are beginning to think about food in terms of long-term health, and will probably make choices in the future in terms of the health-promoting aspects of foods more so than they have done up to now.

We are looking at the economics of farming, which are relatively uncertain at this time. It is an economics built on a technology that has been constructed for, we might say, maximum yield. We have had a whole set of technologies, such as those in breeding, fertilizers, plant protection, veterinary pharmaceuticals, artificial insemination, mechanization, and so on, that made these maximum yields possible. It seems in the future that we may have to develop and select technologies that can produce maximum return.

We also have issues of environment itself, there are pollutants that can impact farming as well as pollutants that may be farm-generated. Also, hostility exists somewhat in certain fractions of society toward chemicals and toward biological innovations.

We clearly have limited resources in agriculture. The area of soil conservation is one of growing concern. The area of adequacy of water, the efficiency of water use will certainly become more important to our agriculture in this changing environment.

Energy, although it is not center stage at the moment, does have a key role in agriculture in terms of the energy requirements in fertilizer and fuel, and undoubtedly at some time down the road energy cost components will again become troubling for agriculture.

As well as these national issues, there is a set of international factors, the fact we are so successful in producing commodity grains that we need to export a large proportion of those grains. Export markets grew in the 1970's, but we learned that they are subject to dramatic year-to-year variations. Such fluctuations may represent changes in other exporters, subsidies, et cetera, or it may represent countries that are aggressively moving to self-sufficiency themselves, or even, as in some cases, a movement from importers to self-sufficiency to becoming exporters. So, clearly, in this changing, dynamic, and increasingly interdependent world, our agriculture has vulnerabilities that it did not have heretofore.

There also has been discussed in earlier testimony this afternoon on changes that the impacts of evolving technologies will provide. Clearly, one feels that the new biotechnologies are going to be very important in terms of our agriculture production and in terms of our agricultural input industries. New biotechnologies should provide a lot of advantages for maintaining, or maybe hopefully increasing our competitiveness.

At the same time, but probably longer term, we need to look at what biotechnology will do in terms of the world balance of agricultural competitiveness, and I might suggest the hypothesis that these biotechnologies, as was brought up by the chairman a few minutes ago, may have in the longer term more beneficial impacts in the productivity of countries outside the U.S., outside the developed world, than within the developed world.

Examples that I might suggest are technologies that would enable the aluminum toxic soils of South America to became highly productive, technologies that might in fact produce wider climate tolerances in plants and allow, for example, the USSR to be a more steady producer of its needs. Thus, we need to prepare ourselves to cope with such changes that may be accomplished.

With such changes through the new biotechnologies, that I think are clearly on the horizon, what then can we do to better the position of U.S. agricultural production and input industries to cope in the future. Research and technology is very key. At the top of the list I would put people. In recent decades has I don't think agriculture obtained its fair share of the most creative minds.

The National Science Foundation special postdoctoral fellowships mentioned earlier are a very creative way to attract these minds outside of agriculture into agricultural research. I think we have a major responsibility to inform young people, at a decisionmaking time in their lives, about the challenges that agriculture offers at this time, so that more of them will be attracted to solve some of these very challenging and very exciting problems.

After people, I would emphasize training. Clearly, we need to train our scientists in the new technologies. We not only need to train new scientists, but we need to establish programs to retrain established scientists in these newer technologies. One of the difficulties that I foresee at this time is the inadequate number of scientists trained in the agricultural sector that are at the cutting edge of biotechnology, and so there will be a somewhat difficult period in the short term in providing enough internal training capabilities to meet the training needs that exist.

The third ingredient of this changing environment in research and science to cope with is the funding area. Clearly, we need new research initiatives to meet these challenges. If one looks at the health science and the medical field, competitive grants over the last several decades have enabled that area to build a significant base of science, on which to provide new technologies and new opportunities.

The agricultural community a few years ago initiated a modest competitive grants program. I am encouraged by the modest competitive grants program at USDA that is being proposed for the fiscal year 1985 budget in the biotechnology area.

As previous speakers have indicated, there is substantial additional need beyond the dollars that are being now proposed, and one would hope that aggressively in the next few years one can provide additional dollars.

I would like to comment briefly on the type of competitive grants that I think might be most useful. Historically, most of our competitive grants have been single-investor- single-discipline grants. Because of the multidisciplinariness of agriculture, I think it is desirable that a percentage of these, a percentage established in advance of competitive grants, be in fact for multiinvestigator, multidiscipline initiatives. These will address more effectively the problems that exist in agriculture. As the following speaker will comment, the McKnight Foundation is a modest example of that type of multidisciplinary, multiinvestigator initiative.

In addition to the advantages in terms of doing the science, I think there are major advantages in multiinvestigator, multidiscipline initiatives in terms of training people. We need scientists who are going to be very comfortable in working across disciplines. In general, our training system at this stage does not create these multidisciplinary scientists, and I think such training in the future would provide scientists, whether they work in industry, in Government, or in academe, training in an environment that would make them comfortable in win-win games in multidisciplinary interactions.

I comment next about facilities, especially the instrumentation that will be needed to do biotechnologies significantly different what is used now in established type technologies. We are clearly going to have to provide funding to update our facilities to match the needs of these sciences.

The science and technology opportunity, as I mentioned in my opening comments, is fantastic at this time, but the science and technology opportunity is not unique to the United States at this time. If we compare what we are doing with the United Kingdom or with Australia, I think we have some cause for concern.

I recently had the opportunity to be a member of an outside review committee for the plant industry division of the Australian Commonwealth Scientific and Industrial Research Organization. I was impressed by the advances that they have made in inserting the newer technologies broadly across their plant science research activities.

Clearly in these areas, the new techniques including genetic engineering, monoclonal antibodies, and other bioengineering areas are going to be key, and I think as our base of information expands there will be sets of other techniques that will also become important.

There have been many activities up to this stage that have identified what are the priority areas that should be pursued. I mention one example, and this is not to exclusively indicate, but only an example, the 1982 Cosepup report [Committee for Science and Engineering for Public Policy] indicated what it thought were priority areas in the plant sciences, and it is my understanding that a similar activity will be going on in 1984 with respect to the animal sciences.

We need, clearly, to expand the science base in agriculture. These new technologies will rely on molecular levels of approaches as opposed to nonmolecular levels in the past, and in general we do not have a very good base in identifying what are the target molecules that will be important in terms of genetic engineering in plants, or in terms of genetic engineering in animals.

We need to move toward understanding what are the regulatory aspects in gene expression, regulatory in the sense of turning on and turning off gene systems, because I am convinced that that knowledge will be key for the agrichemical input industry of the future.

We also need to recognize that we are not restricted to the genes that nature has so far evolved. Chemistry is at the stage now where we can begin to think about designing genes which could be superior genes and improve various aspects that we may wish in crops or in animal situations.

These new technologies then, we can say broadly, are expected to provide products, processes or services for many needs of animal and plant agriculture. They will clearly have high potential for the United States, but also for other developed countries, less developed countries, and the centrally planned economies. These products are expected to decrease the cost of production, increase yield, reduce vulnerability to stress and pests, stabilize yields, reduce risks, and expand the useful world cropping land.

Where are we at this stage? Model gene transfers have already been accomplished in experimental plants and animals, and one expects that within the next year or so transfers of simple agronomic traits in plants and possible use of characteristics in domestic animals will be accomplished. However, it must be recongized that these new technologies are relatively untested. Our enthusiasm is high, but their utility for the most part remains to be demonstrated in the marketplace.

If we fund and create a substantial new base of scientific information in the agricultural sciences, we are going to have to aggressively develop effective technology transfer. Various experiments in industrial university relationships are occurring at this time and from these experiments we will find the ones that are useful to duplicate, and the unuseful ones, hopefully, will not be followed. There are also various groups meeting such as the academy's group that is concerned with a dialog between university, Government, and industry people.

With an expanded thrust in agricultural science, it is clear also that we need to think about accountability. With an expanded thrust we are going to have to set in place a sophisticated way of evaluating the scientists and evaluating the science that is occurring. That sophisticated way certainly has to emphasize quality, and I hope would not emphasize only quantity such as the number of papers that might be published.

Let me summarize, then. U.S. agriculture production in input industries will need to compete in a more rapidly changing world environment. Many factors support this accelerated rate of change. Several factors, people, training, funding, facilities, programs, technology transfer, and accountability are identified as key to providing a strong base of science and technology to maintain, or hopefully even increase, the competitive position of our U.S. agricultural industries.

I thank you, and would be happy to answer questions.

[The prepared statement of Mr. Hardy appears at the conclusion of the hearing.]

Mr. BROWN. Thank you very much, Doctor. Mr. Roberts.

Mr. ROBERTS. Yes, Mr. Chairman, I do have questions.

I want to thank you, Dr. Hardy, for an excellent statement. On page 3 of your statement you note, and I am quoting here: "The economics of farming is changing drastically with the future of many farmers uncertain." I would say that is certainly a true statement out in my country. Then you go on to say in the next paragraph on page 4: "Future agriculture research may need to focus on reducing costs of production in order to maximize return rather than maximize yield." Can you tell me where you are in this kind of program? I know my farmers would love to reduce their costs of production.

Mr. HARDY. I think one can make a rational case that the new biologies should allow the generation of technologies that may be lower cost in terms of inputs then maybe some of the technologies that we have now. If one, for example, looks at seeds as the ultimate result of some of this new technology—seeds are a relatively easily reproduced and not hugely energy consumptive, for example, as is a fertilizer.

Having said this, one has to admit, however, that we are very, very early in identifying how to do these particular things. The example of a self-fertilizing nitrogen-fixing plant is often brought up by the press. Yet the reality of that occurring in a reasonable timeframe I would judge is fairly remote. That is one of the more complex things that I think you could address.

On the other hand, there are simple, single gene-type situations that within a few years we are going to be able to move and express.

Mr. ROBERTS. On page 7 you go into, in the second paragraph: "Research is needed to provide the basis for making higher value-in-use products than commodity grains. Such technology could significantly increase the competitive position of U.S. production agriculture". Could you go into that a little bit more?

I was intrigued and I must admit I didn't pick up everything you said about making the Soviet Union a steady producer. That certainly got my ears to perk up. I wondered if you could amplify a little bit on that. I am not sure I really understand what you are saying in that second sentence.

Mr. HARDY. We have had a historic ability in this country to overproduce, especially in the grain area, well beyond our own needs, and maybe beyond the world's ability, the rest of the world's ability to pay for what we have produced. We have seen that in our commodity grains in recent years.

There have been thrusts in the past—there were thrusts, as I understand it, in the 1940's in terms of developing regional laboratories within the USDA, to seek ways of developing new uses for agricultural products. I think with the new sets of technologies that we have at the moment, that it is appropriate for us to reexamine not only what will these new technologies do for us in terms of the production end of agriculture, but what will they do for us in terms of converting agricultural products to something that has high value in use either within the United States or external to the United States.

Again, I cannot give you hard examples of what the specifics would be. I think there is a major opportunity for us there.

Mr. ROBERTS. If you need some samples of hard red winter wheat, I know where you can get some.

On page 12 you state:

> We need also to understand the regulation of gene expression in plant and animal cells. Such knowledge will be a key in developing molecules to turn off or turn on genes at desired times. This ability to regulate genes may be the key to the agrichemical input industry of the future.

I told the chairman I would not steal his line, but this sounds like a designer gene of the future. At any rate, do you mean to say that you think you can come up with, down the road, something that would make it possible for Chairman Brown and I to put FIFRA on a long-term basis?

Mr. HARDY. That is a little complex to respond to.

Mr. ROBERTS. That is an unfair question for anybody, I understand that.

Mr. HARDY. I think it is reasonable in our evolving knowledge to suggest that we will be able to identify small synthetically produced molecules that will enable us to turn on activities in a plant at an appropriate time in its growth cycle. Say, for example, we may incorporate into a plant the ability to make a toxic substance to insects. In general you are probably not going to want that toxic substance produced throughout the whole life of the plant.

In fact, as it approaches the marketable stage you probably want very little of that toxic substance so that it would not carryover into the food chain. What I am suggesting here then is, with these new genes that we put into plants, we will be designing molecules to cause their expression, their functioning, at specific useful times in the growth phase of the plant. One could make the same argument in the animal agricultural area.

There are one or two examples now known in science where we can point to exactly an example where that is occurring, where a small molecule is causing the turning on of a particular gene that would not, without that small molecule, be turned on at that time, so it is not phantasy. It is a long-term projection, and I think it is an important opportunity.

Biotechnology is going to be important, I think, to all of these segments of our society. It will be important to our agricultural production industries. It is going to be important to the competitiveness of our agriculture input industries, which will be key, if we are the leaders, in terms of substantial export market of those agriculture input materials.

Mr. **Roberts**. Do you have a kind of policy sharing with the Department of Agriculture to the extent that if a breakthrough would occur in any of the examples that you have indicated with our competitor nations in terms of farm exports—this is a rambling rose question—that you could inform the Secretary of Agriculure and those of us who devote most of our time to agriculture program policy, that you could say, look, down the road 2 years from now we are very close to a breakthrough in regard to—let's just take the Soviet Union, and they will become a more steady supplier.

Obviously, if that is the case, barring embargoes and things of this nature, that really puts a different light on the supply management policy alternatives that we have to consider before the full committee, and as a matter of fact was a subject of debate on the floor today. I am just wondering, does the left hand know what the right hand is doing at the USDA down the road in terms of these warning flags?

Mr. **Hardy**. I doubt that industry would be the one that will have the best tie in terms of, for example, is a crop that is going to be aluminum-resistant being developed in South America, or is a crop that is going to be more climate tolerant being developed in the U.S.S.R. I think there are other sources that one is going to have to rely on, other than industry. Industry's focus is going to be more on those agriculture input industries where industry feels there is an opportunity to market products.

Clearly, we are going to have to watch carefully what is going on in the rest of the world, and my hypothesis—and it is only a hypothesis at this stage—is that biotechnology long term may have more impact outside the United States than within. That it may reduce the competitive advantage of U.S. production agriculture, and this is a long-term situation.

Mr. **Roberts**. That is what I am talking about.

Mr. **Hardy**. Well beyond the year 2000. I think we need to get the best minds together to address the reality, the best thinking in terms of is that highly probable. If that is highly probable, then we need to start to do research in terms of what other crops, what other products can we produce.

Mr. **Roberts**. Are you sharing this kind of information with the USDA? That is really what I am asking.

Mr. **Hardy**. We are sharing this suggestion broadly. There was a meeting that we had at the National Academy of Sciences 2 weeks ago on technology projections and foreign relations. I talked at that meeting, and that was one of the points that I raised at that particular meeting. There was a broad attendance from across the Washington community that was at that meeting. Let me emphasize, however, it is a hypothesis.

Mr. **Roberts**. Yes, I understand that.

Mr. **Hardy**. At this stage. Shorter term biotechnology is going to increase the competitive advantage of U.S. agriculture. It is the longer term one that I have some concerns about.

Mr. **Roberts**. But you are making a point that on the strings of such, the future of farm programs hang. If you increase that yield to the extent both in this country or in any other country and your farm supply management program doesn't work for many different reasons, many of the projections that we have to rely on are simply not accurate.

I might add you might share that with my colleague from Missouri who just got $450,000 for the University of Missouri to do all that kind of planning. I don't have his attention right now, but at any rate I would hope that the USDA, that you would work in close contact with the USDA. I think it is fascinating.

Mr. **Hardy**. Let me add there are I think excellent relations developing between the Board and agriculture, as represented by the USDA. The fact that we are doing a study of ARS at their request in terms of where are the best places for them to focus at this particular time is one example.

Mr. **Volkmer**. If the gentleman from Kansas will yield, you got my attention on the floor. You don't get any more.

Mr. **Roberts**. I have no further questions, Mr. Chairman. Thank you for the time, Mr. Chairman.

Mr. **Brown**. Does the gentleman from Missouri have any questions?

Mr. **Volkmer**. I have no questions.

Mr. **Brown**. Dr. Hardy, we just have a few minutes and then we will recess for a vote, but I am very much impressed by your statement. This may be one of the most focused hearings on the area of plant biotechnology that has been held in the Congress. It is my intention to make sure that the printed proceedings of this hearing are widely distributed, not only to the committee members but the Appropriations Committee members and other Members of Congress. I think we are the stumbling block right now in perceiving some of the potentials for moving ahead in this area.

Having said that, you point out in your own statement on page 4 the need for agriculture to communicate more effectively with society, so that society can have a more balanced view. As agriculture becomes the smaller and smaller percentage of the total of society, this becomes more and more important. I hope that you will see part of your role on the Board on Agriculture at the NRC as facilitating this interaction. I think you have a great opportunity on the Board, and I wonder if you perceive it that way.

Mr. **Hardy**. I think it is a broadening arena, and clearly the consumer has I think an increasing interest in agriculture. If one thinks of recent reports like the possible relationship between food and cancer, I think that consumer interest will tend to grow in terms of what foods will provide long-term health, whether that is health of the immune system or the neural system or other aspects, and so I think there is an opportunity, just as you have said, for the Board on Agriculture, and I think there is also an opportunity in agricultural research, to address some of those aspects.

Mr. **Brown**. As a part of our effort to educate the Congress, what we need to emphasize is the possibility that we are lagging behind some other countries, and I note your complimentary remarks with regard to the progress being made in regard to Australia. The Members of Congress and the United States in general would feel very bad if a small country like Australia were to get ahead of us in an area like this. Would it be possible for you to provide the committee, for this hearing record, some additional information based on your study in Australia?

Mr. HARDY. I would be happy to submit, after I get back to Wilmington, a comment on that. It is a small activity in dollars, $15 million approximately, but it is a concentrated activity in terms of the plant sciences and the integration of biotechnology that I don't think I have seen elsewhere in the world, with the exception of the Plant Breeding Institute in the United Kingdom.

Mr. BROWN. We would appreciate it if you would do that. We will keep the record open for it. Much as I would like to continue further with you, I think that we will recess at this point and excuse you so that we can proceed with the additional witnesses.

[The information follows:]

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EXPERIMENTAL STATION

June 7, 1984

Honorable Congressman George E. Brown, Jr., Chairman
U.S. House of Representatives
Committee on Agriculture
Subcommittee on Department Operations,
Research and Foreign Agriculture
Room 1301, Longworth House Office Building
Washington, D.C. 20515

Dear Congressman Brown:

The following comments will amplify my brief statement on the Australian Commonwealth Scientific and Industrial Research Organization's Plant Industry Division. This information is based on my membership in a review panel for this Division in March 1984.

The Division is headed by Dr. James Peacock, one of the world's leading plant molecular biologists. It is supported by the Australian government and a modest amount of contract research to a total extent of about $15 million supporting approximately 140 PhD-level parmanent staff scientists. Its function is to provide a base of understanding for the plant sciences from which Australian state and private laboratories can generate new plant varieties and other products.

This Division, in my judgment, is one of the two most oustanding concentrated programs in plant molecular biology that now exist anywhere in the world. The other one is the Plant Breeding Institute at Cambridge in the U.K. The Australian Division is organized on a program basis which brings together a variety of people from different disciplinary areas. There are a total of twelve program areas. Some of these programs areas are involved with the molecular basis for plant improvement, plant growth and development, regulation of plant storage proteins, photosynthetic processes, nitrogen in agriculture, weed control, crop adaptation and agricultural systems, and dry land crops and soils. Almost all of these programs had the new techniques in biology incorporated within their activities to some extent. This was achieved, I believe, in large part to the strong leadership and the strong scientific skills of the division head in these areas. It may be appropriate for U.S. agriculture to examine this model as molecular biology becomes a more important part of U.S. agricultural research activities.

Sincerely,

R. W. F. Hardy

RWFH/gdm

[Recess taken.]

Mr. **Brown**. The subcommittee will come to order.

I wonder if Dr. Caldecott would come forward. Dr. Caldecott, we apologize for the disruption to the schedule. I am sure you appreciate the problems we are suffering under here with the members wandering in and out as they are. I am going to ask you to go ahead and present your testimony so that we can move along as fast as possible in the event we have another rollcall. Would you proceed with your testimony?

STATEMENT OF RICHARD S. CALDECOTT, DEAN, COLLEGE OF BIOLOGICAL SCIENCES, UNIVERSITY OF MINNESOTA

Mr. **Caldecott**. Thank you very much, Mr. Chairman.

My name is Richard Caldecott. I am currently dean of the College of Biological Sciences at the University of Minnesota, a position which I will relinquish in the middle of the month to take on another position for the president of the university for technology transfer.

Mr. **Brown**. We haven't hired you out in California, have we?

Mr. **Caldecott**. Not yet.

I want to emphasize that I am not here to speak for the University of Minnesota. When your subcommittee requested that a representative of the McKnight Foundation come forward and talk about their program, the director of the McKnight Foundation indicated that he wasn't available and asked me if I would come in his stead.

I accepted that challenge with a good bit of enthusiasm because I think what the McKnight Foundation has done is a unique and a bold initiative, the kind of initiative that surely must be emulated by the Federal Government and various of its granting agencies if we are to succeed in this competitive world that we current exist in.

Before I provide the rationale, however, for the establishment of the McKnight Foundation program, I would like to diverge and address the issues of the draft charter which I was asked to comment upon. I think it is very important to make it clear that we cannot emphasize too strongly in this country the great success that the scientists have had following World War II. It was virtually all made possible by funds that were provided by the Federal granting agencies to major research universities.

Now the support, as you well know, is given primarily through peer review awards for research and training that were given to individual scientists for studies that for the most part were disciplinary in nature. I think that with the exception of the USDA, which was really not a significant party in the process, the infrastructure that has been developed is unmatched anywhere in the world and indeed I feel that much of what we are here to talk about now is how we bring the USDA to that kind of an infrastructure.

I think at the same time that we have this excellent infrastructure, we must not stand pat with what we have because it would be a tragic mistake. It would be a particularly tragic mistake, as it relates to agriculture. What I would like to do, Mr. Chairman, is make a few assertions to get them on the record that I think the subcommittee might wish to think about now and in its future deliberations.

First and foremost, the integrity of that peer review process to which I referred, it seems to me, must be protected and must be expanded with respect to general support for the scientific community and specific support in agriculture.

Second, that a rigorous process absolutely must be developed encouraging and reviewing proposals from groups of scientists who wish to use team approaches in solving problems and particularly in training students, and I will come back to that one later on in my testimony.

Third, a method must be found to assure that the rewards from research conducted in the laboratories of U.S. scientists result in employment opportunities in this Nation and appears on the balance sheets of U.S. corporations rather than on the corporate balance sheets of our international competitors.

Fourth, that steps must be taken to guarantee that both the scientific infrastructure and the financial support provided for research and training will be maintained at a level that assures that the national security and health and welfare of the citizenry never will be compromised.

In this regard, I think that such a compromise certainly will occur if major State-supported research universities that are currently under great stress because of enrollment declines aren't funded in a way that is more compatible between the State system and the Federal system. I think the State universities at the current time are in real jeopardy, that as enrollment falls, the number of positions that they have in those institutions is going to drop off. As that happens, the amount of research that is getting done within those institutions will decrease in a proportionate way.

I think what most of our legislators don't take into account when they handle the funding of universities is that the faculty in those universities are doing an immense amount of research for the Federal Government which pays off in benefits both to the State and to the Nation, and it would be very, very shortsighted, indeed, for them to cut back on those faculty members.

I hope then that you will address at some time during your deliberations the obvious way to overcome that particualr problem, and that is to develop somewhat of a more normalized partnership between the State and the Federal governments in terms of funding scientists. I could recommend to you a procedure that has been used by the Department of Agriculture in the past and is still used, and that is the full funding of scientists through the ARS member universities. I happen to have had the privilege of being one of those for 11 years, and it was a beautiful relationship, although I might add always ill-funded and I guess who wouldn't be?

When the McKnight Foundation decided to undertake a program of forward looking research in the plant sciences, they really had one principal objective, and that was to finance state-of-the-art research that could be expected to have a positive impact on agricultural production in the year 2000 and beyond.

Now, to determine a strategy that would likely help the foundation achieve this goal, a series of meetings were held with me, as the program chairman since the beginning, with scientists in several universities, representatives of three Government agencies, and the management of the foundation.

The result of those deliberations with that group of individuals was the presentation to the foundation of a number of areas that we felt needed funding for interdisciplinary research and for individual program research, and those areas I have listed for you on page 4 of the submitted testimony. I know time is short, and I don't want to run through all of them. Let me make a couple of comments.

No. 1, the establishment of cell and tissue culture techniques, which can be used in whole organism regeneration. Fundamentally what has happened in the last few years is that plant scientists have found ways to grow single cells in culture the same way that bacteriologists and microbiologists grow micro-organisms in culture. They can manipulate the cultured medium and manipulate those plant cells in such a way that they can elicit from them products and processes that can be of benefit to agriculture.

So rather than having to go to the field and grow, perhaps, as much as hundreds of acres of a specific variety of corn or soybeans or wheat, or what have you, they can do a good bit of the screening in the test tube. The method is not completely perfected yet. They are finding that it has got a few vagaries in it that are going to require a lot more refinement. But that kind of a step, once perfected, ought to allow a turnaround time for a new variety of our economic crops instead of being 10 to 20 years turnaround time, perhaps in 2 or 3 years.

I would make a comment on one other of those groups of areas that I listed there, just because I think it would give you another example of what we are talking about rather than belabor what is in the submitted testimony anyway.

Item No. 6, deals with the molecular basis of the response of plants to fungi, viruses, bacteria and insects and the impact on the environment of that response. What I would like to point out to you is that we don't know yet in any substantive way what happens when a micro-organism invades a plant. We have nowhere near the ideas on what happens that we do in a warm-blooded animal system where you are all very, very familiar with an immune response.

There are no such immune responses in plants. If there are, they are resident in the few cells that are associated with the infection of the fungus. So there is an immense amount of work to be done in the area of what I would call host-parasite relations and to effectively succeed in that area could be monumental in its importance to agriculture.

If you will reflect back to the 1920's and 1930's, when rust epidemics literally were rampant in the Mississippi Valley, talking about stem rust epidemics, one of the things that saved them was an arduous, tedious transfer of a gene from one species of wheat to another species of wheat and screening process that took about 15 or 20 years. Hopefully, one could do that in a matter of days or weeks or, at best, months using some of these modern techniques.

Now, solutions to those 10 problem areas that I outlined for you on pages 4 and 5 of the submitted testimony that were identified as being important require varying degrees of integration and coordination of research interests of individuals who come from very divergent backgrounds. It really does need everything from a molecular biologist, perhaps even a biophysicist, to a plant breeder working in the field.

So the McKnight Program was designed to be broad enough in scope to provide funding of two sorts. The first was for a promising young scientist who, for the most part, was working in relatively well defined areas and can use a 3-year period for concentrated studies. Most particular, awards are not unlike the awards that you typically see given by the Federal granting agencies to both new oncoming scientists and those who are well established.

The second and the perhaps more novel thing that the McKnight Foundation did was to fund groups of individuals who are working in an interdisciplinary mode to try and accomplish objectives that no one of them could accomplish using their own individual talents.

So really it was a pooling of diverse talents, and I think if we succeeded in doing anything, it is bringing those kind of groups together both in the universities that have been supported and also in a lot of universities that were not supported and saw the challenge.

Obviously, the McKnight Foundation knew that it couldn't provide funding for all the programs that were worthy, so they wanted to find a way to play this extremely important key role and then be a stimulus for support by others and particularly by the Federal granting agencies. From what I have seen, it looks like they have succeeded.

It was also decided that the programs that were to be financed had to earmark major fractions of the funding for graduate students. This is something that we too often neglect and indeed one of the problems that university scientists have had with the Federal granting agencies over the years is that the granting agencies have wiped out the requests for support of graduate students.

I was pleased to note recently that I understand the Director of NSF has reversed that policy and has been encouraging that as a method of funding students. After all, it is these people that are being funded, the young people that are being funded as graduate students and post doctorates that are really the future of science in this country. It is not the old guard, such as me and many others, who are represented in this room.

Now, it was agreed by our committee, which the McKnight Foundation supported fully, that the funding for the individual awards would be a nonrenewable commitment of $35,000 per year for 3 years, and we have actually made 10 such awards of that nature. Believe it or not, they range all the way from Vermont to Montana, and one is actually at the Stock Institute, which one doesn't typically think of being a plant science center.

The initial funding that we gave to the interdisciplinary awards ranged from $200,000 to $300,000 per year for 3 years. We have made six of those awards.

The foundation reserves the option to continue those interdisciplinary awards for periods in excess of the initial 3-year commitment. It will not do that with the individual awards, so there will be another new round of individual awards, an announcement for a new round of interdisciplinary awards with the expectation that a significant number of those will be carried forward for a second round.

The total amount of money that has been put into the program is $1,850,000 per year for 10 years, and I think it is rather remarkable that a foundation such as the McKnight Foundation, which is usually associated with the social sciences more so than the life sciences, has agreed to put that kind of money in over a 10-year period.

I think that another aspect of the McKnight Foundation awards was the approval by the Board of a unique review process, and I want to describe that process to you, because I think it is very important. We typically in our academic settings request that the professors who receive grants come forward and talk about those grants at a variety of different meetings and review panels and the like, leaving behind in the laboratory the people who have done an awful lot of the work. So that one of the features that has always intrigued me, and which I take some credit for talking the foundation into doing, is giving our committee up to $50,000 to review those programs by bringing together in one place all of those individuals who are trained.

I am talking now about the students, the graduate students, and the post doctorates along with their mentors. But the people who will make the presentations will be the students and the mentors will sit there and have to see their students compared with the students of every other university grouping that is present.

What that will do for those of us on the committee is allow us to make the kinds of comparisons we would like to make between the quality of the student at university A and the quality of the student at university B. And I think that is going to be extremely important to us.

Now, the foundation was aware that on several other occasions, agencies, Federal agencies, had attempted to get interdisciplinary research started. They knew that the proposals that were submitted to the various granting agencies were often wanting in terms of scientific rigor and also obviously in quality.

There are several reasons for this deficiency that I think need to be brought out on the table here today. The overriding one no doubt is that the funding of scientists by the granting agencies usually emphasizes the individual and what he or she can contribute scientifically as an independent investigator.

Now, typically the universities reinforce this bias and the way we reinforce it is by making our tenure decisions and our promotion decisions on the basis of the achievements of the individual as an individual. A system that is driven in this way, both by the Federal agencies and by the universities, certainly assures that the very best of the scientific community are going to go down a relatively narrow path and in so doing look for tenure to be achieved and their own merits to be forthcoming in terms of salary approval.

There is no doubt in my mind that this approach will continue and must continue in the universities, but it is also very important that the universities and the Federal agencies look for other ways of approaching the problem.

The way we do it now, we ask individual investigators to learn more and more about less and less. What this boils down to is what we in science call a reductionist approach to looking at scientific problems. You tear the thing apart and look at smaller and smaller pieces of it. There is very little attention given to asking what happens when you put the pieces back together.

What we do know in the biological sciences is that one and one never makes two. One and one always makes three or five or seven. In other words, the parts put together never sum up to being equal to the whole. The whole is always greater, and that is something that requires then that we start to take a hard look at the holistic and the reductionist approaches to biology all at the same time.

I think then that the challenge that I see as a university faculty member and that I hope the Federal agencies will see, and which perhaps you could encourage, is to bring down that system of putting all the dependence on the individual and taking a much closer look at interdisciplinary teams and groups of scientists.

Now, the individuals that we selected to advise the McKnight Foundation were very mindful of all these considerations. We talked them over at some length, and those individuals, two of whom come from Federal granting agencies, and all but one other from universities. One comes from the Cargill Corp. in Minnesota. Those individuals were chosen for their expertise as scientists and administrators and people who have been around long enough to have a feel for the nature of the problems which I have been describing.

I think they have done an absolutely superb job, and I suppose you would expect me to feel that way after having chaired the committee, but I think they have done a superb job in putting forward a unique and a different program.

Now, in total, we received 148 requests for individual awards from the scientists in different universities in this country. We received 89 for interdisciplinary awards for research and training, the large $200,000 to $300,000 awards.

We gave 10 grants away to individuals and six to the interdisciplinary teams. Unfortunately, the proposals we received were quite mixed, and I know that it is very interesting to this committee as to why this occurred. My own view was that the deficiencies in a number of the interdisciplinary proposals were almost entirely related to the fact that teams of investigators had never got into the mode of working together. What they presented to us was a collection of individual proposals, just the way they send an individual proposal off to a granting agency.

It is fair to say that when we got through looking over all those 89 requests for support, however, that we did find a number of good ones significantly greater than those we could fund. They should have been funded by us had we had the money.

So, as I say, we funded six. We probably could have funded 10 more on the basis of merit. We certainly couldn't have gone any further. What I understand, from talking to my colleagues at a number of universities, and Cornell is among them, Wisconsin, and others, is that what happened through the McKnight Foundation awards has been what amounts to a catalyst in stimulating the administrations in different universities to take a hard look at bringing interdisciplinary teams together. So I think that while the foundation has spent correspondingly small sums of money, the payout might be very large indeed.

Thank you, Mr. Chairman. I am prepared to answer your questions.

[The prepared statement of Mr. Caldecott appears at the conclusion of the hearing.]

Mr. Brown. Thank you very much, Dr. Caldecott.

Tell me, how do you handle the overhead charges on this? You have cited just the grant costs. Do you absorb that in the foundation's general overhead?

Mr. Caldecott. We made the arbitrary decision, and I want to emphasize that I wouldn't support such a decision with a Federal agency, but we made the arbitrary decision that the McKnight Foundation could do most by being sure that there was some self-help from the institutions. In other words, if we were to pay full overhead, and it varies, as you well know, from 35 percent to 75 or 80 percent depending on where you are, I guess if we paid full overhead, that wouldn't give to us any indication that the university wanted to be a part of this thing. So we decided 10 percent for overhead.

Mr. Brown. That is not precisely the question I had in mind. The foundation's own overhead in connection with the whole process involved here of selecting the grantees, reviewing the proposals and that sort of thing.

Mr. Caldecott. Overhead is fairly minor because what they really did was to get six people who are fairly competent in their fields to turn their efforts to this program for a total cost of which I am not sure, but I am certain it wasn't the full year equivalent of a Ph.D. I think what I received from the consulting was around $7,000 or $8,000 for the effort.

So it is a beautiful way of getting a lot of work done inexpensively and putting the resources out in the field.

Mr. Brown. That, of course, is one of the benefits of having a private foundation or private sector involved. Governments seem to be able to create a lot more overhead during this process.

Mr. Caldecott. I think necessarily so, Mr. Chairman.

Mr. Brown. Now, I am particularly interested in how you solve this problem of getting adequate, good, high quality interdisciplinary proposals. Tell me something about how you went about this process of getting a half dozen or more highly qualified people in divergent fields to come together around one significant proposal that wasn't just a collection of their individual proposals?

Mr. Caldecott. To begin with, we announced through the foundation that what we would support only was interdisciplinary proposals, and we support them fairly handsomely, as indicated, up to $300,000 a year. So we let that be known in the scientific community.

We already knew where there were some proposals, some research of this type going on, and in two or three cases those places were supported. So what we did was give them a financial incentive and money talks, and I think that is really the way it was done.

Mr. **Brown**. Tell me this. In what kind of setting did you find these people? Were they in land-grant colleges, other research performing institutions of higher learning, any of them in State experiment stations?

Mr. **Caldecott**. Let me very quickly say Stanford University, Berkeley, Davis, Minnesota, Michigan State, Wisconsin. Berkeley is the land-grant university in California, as you may know, although Davis has an experiment station director, and I guess it is considered part of the land-grant system, I am not sure.

Stanford is private. The experiment station directors were, of course, involved in these activities, but by and large the scientists were drawn from departments both within and without the experiment station. So to give you an example at Minnesota, about half the departments are in the experiment station and the other half are not, and that is true at most of the universities.

Mr. **Brown**. I see.

Mr. Roberts.

Mr. **Roberts**. I have no questions, Mr. Chairman, except to thank the witness for a very fine statement. Thank you, sir.

Mr. **Caldecott**. It is a pleasure to be here. Thank you.

Mr. **Brown**. Mr. Volkmer.

Mr. **Volkmer**. I am sorry I wasn't here for all the testimony and to follow on a little bit on the question of the chairman. The grants have been made to the institutions you mentioned. What areas are they directed to?

Mr. **Caldecott**. They tend to emphasize molecular biology, but the one at Stanford bridges the molecular biology and ecological environmental areas, particularly in stress physiology on plants.

Specifically, the one at Michigan State University tends to concentrate on photosynthesis. The one at the University of Minnesota tends to concentrate on improving the storage protein content of corn; Davis, CA, on host parasite relations, in other words, how microorganisms infect plants and why and what the molecular biology of it is.

Mr. **Volkmer**. So we do have different areas in which they are starting their research?

Mr. **Caldecott**. Yes, sir, we specifically tried to choose different areas.

Mr. **Volkmer**. It appears also that the research basically is in areas in which they would have a major concern within that State or that area except maybe the one in Michigan. There is one in Minnesota and, again, one in California.

Mr. **Caldecott**. I think, Mr. Volkmer, I believe the kinds of research going on would have national implications and broad applications across the Nation. None of it is so narrowly focused that it is restricted to a particular geographic area.

Mr. **Volkmer**. I agree on that, but it does have implications within that area?

Mr. **Caldecott**. It certainly does, yes.

Mr. **Volkmer**. The other thing I would like to know is, are any of the research investigators also working in conjunction with any industry?

Mr. **Caldecott**. Yes.

Mr. **Volkmer**. You don't have to name any.

Mr. Caldecott. I cannot be specific. The answer, though, is yes, several.

Mr. Volkmer. Thank you, Mr. Chairman.

Mr. Brown. Thank you very much, Dr. Caldecott. That has been very helpful to us. I wish we could operate as creatively and effectively here in the Federal Government as you have through the McKnight Foundation.

Mr. Caldecott. Thank you very much.

Mr. Brown. Next I would like to call Dr. Sue Tolin, who is professor of plant pathology and physiology at Virginia Polytechnic Institute.

We welcome you here, Dr. Tolin, and look forward to your testimony.

STATEMENT OF SUE A. TOLIN, PROFESSOR, PLANT PATHOLOGY, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Ms. Tolin. Thank you, Mr. Chairman, and good afternoon.

I am Dr. Sue Tolin, professor of plant pathology at Virginia Tech, which is Virginia's land-grant university. I teach virology and conduct research on viruses that cause diseases of major crops.

I also conduct basic research on the molecular and genetic basis on viral pathogenesis and host plant response. I also develop virus diagnostic techniques and work with plant breeders and geneticists to develop crop cultivars resistant to certain viruses. I currently also hold a part-time IPA appointment with USDA, Cooperative States Research Service [CSRS]. Since 1979, I have served as the U.S. Department of Agriculture's representative to the NIH Recombinant DNA Advisory Committee [RAC]. I am also a member of the USDA Recombinant DNA Committee representing CSRS.

I thank you for the opportunity to appear at this hearing and to discuss the type of regulatory approval process for release of new organisms that I believe could be followed to insure protection of the environment without destroying the potential of biotechnology in agriculture. I will emphasize in my remarks those new organisms in which recombinant DNA technology has been utilized in their development, although I recognize that biotechnology can be defined to encompass a much broader area.

My remarks reflect my personal views as an agricultural scientist and are not necessarily those of my university or of the Department of Agriculture. They are perhaps directed more toward plants for two reasons: One, I am a plant scientist; and two, current regulatory questions concern plants and associated microorganisms.

I think it is safe to state that agriculture has a program for releasing organisms into the environment. It is often called farming. I believe it is also safe to state that agriculture does and will continue to alter the environment in various ways. Much agricultural research is directed toward reducing risks to the environment while increasing benefits to both the producer and the consumer. Biotechnology, in my view, has the potential of reducing, not increasing, the risk to the environment of releasing organisms.

It is widely acknowledged that U.S. agriculture is based on the cultivation of many introduced species of plants and animals. Many of our treasured ornamental plants and domesticated animals are also introduced species and none of these have really taken over. We now know that many pathogens and pests were introduced inadvertently. After the fact, in many cases, but continuing today, quarantine laws are in effect to limit introduction of organisms deemed hazardous to human, plant or animal health, or to the environment. These laws are enforced by USDA's Animal and Plant Health Inspection Service, known as APHIS, with the cooperation of State agencies and with many agricultural research specialists, particularly pathologists like myself.

Genetics and traditional breeding and selection techniques have been the basis for research to improve both native and introduced species for increased production efficiency and traits desirable for food, fiber, or aesthetic purposes. Many of these have been alluded to by previous speakers. The genetic basis for important traits is known in many cases, and genes have been manipulated by breeders using many different approaches. Whatever the trait might be, or however it has been manipulated, new varieties or cultivars that are developed are not judged to be new organisms.

The new or modified variety is subjected to the same rules and regulations for research and commercial purposes as were the parent organisms. Protocols are in existence in the various agricultural commodities for testing, evaluating, and assessing the degree of difference from standard varieties. There is a vast network of individuals, from the producer at the local level to the researchers at the State agricultural college, to the Federal agencies including EPA and FDA who are involved in this complex process. Field plantings are routinely made each year at many different geographical regions for the purpose of both developing and testing genetically modified organisms.

I got into this material simply to provide some background before I mention the recent developments in molecular biology and biotechnology which other speakers have talked about. With these technologies, new opportunities are becoming available for increasing our understanding of the structure and function of specific genes in plants and animals, and particularly in the viruses and microorganisms associated with them. There are now many examples in which specific genes associated with pathogenicity or with response to a biological or physical stress imposed on a plant have been isolated and cloned into another host by recombinant DNA techniques.

Molecular vectors have been developed and used to manipulate the genes both in microorganisms or higher organisms in ways far more precise than the traditional ways of crossing or mutagenesis that breeders have used. I will readily admit that biotechnology on the molecular level is in its infancy in agriculture. The potential has been recognized, and with adequate resources, I believe it can be realized in the near future.

The new organisms must first be produced, after the desirable genes have been isolated and the regulatory mechanisms understood. They must be tested first under controlled conditions and then under natural field conditions to recognize their benefits and potential risks. The testing and later commercialization of these modified organisms have raised an enormous number of questions and have produced a log jam.

To look at how we get out of that log jam, let me speak to how we got to where we are now. The release of organisms modified by recombinant DNA techniques has required review and approval by the NIH Recombinant DNA Advisory Committee, in accordance with the "Guidelines for Research Involving Recombinant DNA Molecules." The National Institutes of Health has promulgated the guidelines, but other Federal agencies have been enjoined to comply with them for conduct of research and other activities under their authority.

Nonfederally funded organizations have practiced voluntary compliance. The RAC has utilized the expertise of scientists from several disciplines and from other Federal agencies in making recommendations to change the guidelines as additional scientific information has become available. Specific requests for permission have been granted to conduct experiments requiring approval.

In the early days of the guidelines, less than 10 years ago, most experiments required review and approval. In the political climate of those early days, a request to transform a plant with the Ti plasmid of Agrobacterium tumefaciens was denied by NIH. Agriculture complained about this and began to work with NIH, and as early as 1977 stated that we were interested in releasing organisms into the environment containing recombinant DNA.

Permission was later granted, but at first only at the P3 level of containment. After review of a number of similar requests and establishment of certain scientific principles, the RAC has acted by developing a generic statement for classes of experiments. These generic statements specify the conditions under which research can be conducted following approval of a local institutional biosafety committee, or an IBC, which is formed at each institution conducting the research.

The vast majority of research in progress today now requires only registration with the IBC or is exempt from the guidelines. The most compelling scientific basis for establishing the exempt category is that the change in the DNA that is made could also have occurred by processes known to occur naturally, and that is the organisms in question pose no threat to human health, agriculture or the environment. Research that is not in this category requires containment primarily because the organism itself poses a risk, not because the recombinant DNA are used.

The review of requests to release organisms containing recombinant DNA into the environment is of course in the early stages, but review of risks associated with recombinant DNA has been the primary business of the RAC. Based on its previous experience, approvals for release have been recommended by the RAC when it was judged that the alteration of the genome was of minimal significance to the organism and would in no way be analogous to introducing an entirely new organism.

The question of the property of the organism and the environment was referred to the Department of Agriculture's Recombinant DNA Committee, and the Department was heavily involved in the decision on the organism itself.

In future reviews, I believe that initial review of the engineered organism, the nature of the change in the DNA, and the method by which it was accomplished should be either by the RAC or by procedures that they develop with either simultaneous, pre- or post-review by the appropriate agency with expertise and regulatory authority for the organism in question or its proposed use. In this way, the RAC's expertise would be utilized for review of the molecular nature of the gene sequence(s) altered and for the review of the characteristics of the organism.

Not all of the regulatory processes would be alike. Several agencies might be involved in this type of process. As currently done in agriculture, protocols have been established for release of organisms for commercial agriculture which are based on long experience and careful observation by a network of scientists.

The efforts described by Dr. Baumgardt in research, education and extension will provide, I believe, additional scientific information and also education of the public and of our own scientists for using this type of regulatory approach for organisms and is of importance to agriculture.

That concludes my formal remarks, but I would be pleased to answer any questions.

Thank you.

[The prepared statement of Ms. Tolin appears at the conclusion of the hearing.]

Mr. Brown. Thank you, Dr. Tolin.

The subject of regulation of genetically altered organisms which are released into the environment has been the subject of a recent court test, has it not?

Ms. Tolin. Yes.

Mr. Brown. I am thinking of the organism which had the capability of altering the frost resistance in certain plants.

Ms. Tolin. That is right.

Mr. Brown. What is the current status of that situation?

Ms. Tolin. The current status is that Judge Sirica granted a preliminary injunction to the plaintiffs on that particular case, and stopped the experiments in question for the University of California.

He also said that the NIH should, until it complies with the National Environmental Protection Act on this, discontinue reviewing proposals for experiments, release of experiments that have been funded by NIH funds or conducted in institutions having NIH funds.

Mr. Brown. Does this indicate the possible need for the establishment of some structure which would provide for the regulation of this situation? You have indicated that you felt that the present system of reviews was adequate, but obviously it isn't meeting the whole situation, the whole need?

Ms. Tolin. It is not meeting the entire need, and perhaps it was the process of review. Now NIH does review these, and did review these proposals in an open forum, the ones that are in question, and it was available for public comment. However, the complaints came after the decision was made, so that the NIH was not able to change their statement or their judgment on why they approved the release until after it was already made.

As I said, the ruling was made not on a scientific basis but it was made on a legal ruling that the National Environmental Policy Act was not followed in that NIH did not file an environmental impact statement for their program for release of genetically engineered organisms.

Mr. **Brown**. That, of course, implied a finding by the judge that the activity involved had come through the purview of the National Environmental Protection Act?

Ms. **Tolin**. Right.

Mr. **Brown**. But the Congress can change that if it chose to do so?

Ms. **Tolin**. The comments of members of those involved in making these approvals stated at the February RAC meeting that they did not recommend filing an environmental impact statement because they felt that this organism would have no effect on the environment.

Mr. **Brown**. Mr. Roberts.

Mr. **Roberts**. Sometimes I feel like that organism, Mr. Chairman. Thank you.

Mr. **Brown**. You are not having any effect on the environment.

Mr. **Roberts**. I am not having any impact on a lot of things. We have heard the argument that a clear Federal statute—this is along the same lines as the chairman has indicated—is needed to, what, guide the approval process, and that this might reduce the court challenges on down the road. Would you favor such a statute? I am not making an argument for or against. I just want your opinion.

Ms. **Tolin**. I cannot favor such a statute that is limited to the genetically engineered organisms. I think the scientific information over the last 10 years since the discovery of the technique has not produced information stating that the use of the technology actually does provide a risk, and I think we need a better education of the public by the scientists involved to show that additional legislation is not needed for this technology.

Mr. **Brown**. Would the gentleman yield?

Mr. **Roberts**. I would be delighted to yield at this point.

Mr. **Brown**. Dr. Tolin, the argument that you have used there, the reasoning that you have used there—we are not trying to be argumentative—is used frequently in situations where an enterprise is seeking to avoid regulation. This applies to the chemical industry and various others. Whenever we have a bad accident involving a pesticide, for example, it is the general tenor of the industry to say, well, the material is safe.

It wasn't used according to the label instructions. Genetically engineered organisms might be safe if they were handled entirely by scientists who understood whatever potential hazard they had, but in this fallible world of ours, we need to be protected against mistakes too, and for that purpose we sometimes need mechanisms. Have you explored that line of reasoning and determined if it has any validity?

Ms. **Tolin**. Yes, and that is why I believe——

Mr. **Brown**. Let me give you one more example. Out in California we released a lot of sterile males, perfectly harmless as far as I know, except that the procedure—this is insects.

Mr. **Roberts**. I was going to ask you for a clarification, Mr. Chairman.

Mr. Brown. Perfectly harmless as far as we know, except that once in a while the factory producing these sterile males makes a mistake and puts a lot of nonfertile—I mean it hasn't worked. Now, you might say, well, if the process works well, there is no need for regulation. But how do we handle the process if it doesn't work well? In other words, should the factories be inspected? Should we have standards that only one in a million can fail the test of sterility or whatever?

Ms. Tolin. What I am saying is that at the research level, I think that the RAC has dealt with review of experiments for the research level. The initial requests have been for release on test plots on the research level. The approvals were not for large-scale release for commercialization. I think at the time that the requests do come in for commercial application of genetically engineered organisms, there will need to be regulations by agencies.

Mr. Brown. Go ahead.

Mr. Roberts. I think that pretty well answers the question or the line of questions that I had in mind. Thank you.

Mr. Volkmer. Will the gentleman yield?

Mr. Roberts. Yes, I will be glad to yield. Are there sterile males in Missouri that you are releasing?

Mr. Volkmer. A little bit different tack based on the same question as to the need for language. Do you envision that somewhere along the line that genetically engineered plants, et cetera, and organisms, that there is going to come a time when there may be a tradeoff?

In other words, we see this and many other things not only in chemicals and everything, the good as against the bad. Sure, that is going to happen, is it not, that there could be some problems with doing it, but the good is going to overcome it? That it is needed as a necessity now, and who is going to make that decision?

Ms. Tolin. I think that the experience of plant varieties can perhaps be used as a parallel, because when we release a variety that is resistant, say, to a current strain of rust or to a current virus that is there, we know from what we know of the biology of the organisms now that there will be a new strain that will develop a few years down the road that will break the resistance of that gene.

Some of the biotechnology that we are able to do now can help us seek molecular answers to that or understand that interaction on a molecular basis, but the fact that we know that resistance will break down in a few years has not been a compelling argument for not releasing the resistant variety to start with.

Mr. Volkmer. Thank you.

Mr. Brown. Mr. Evans.

Mr. Evans of Iowa. No.

Mr. Brown. We have had at least some tentative discussions with the EPA people that perhaps a simple extension of the authority that they have to regulate toxic chemicals, pesticides, insecticides and fungicides might suffice to deal with this problem.

I think the position of the agency at this point is that we are not far enough along to be able to determine that. We are not trying to force that, but we do have to identify what would be a logical agency or agencies, there could be more than one. We have Food and Drug and EPA and others who get involved in this matter of chemicals in the environment. Do you have any thoughts as to whether there is a particular preferred route or agency here, or when we might be able to make a decision as to what would be the best way to go on this?

Ms. Tolin. People involved in different agencies have been in fairly close communication with each other, so I am aware of what EPA is doing and they are aware of our approaches in this too. I think right at the current time it is too early to state that one agency will handle all release of all recombinant DNA molecules.

Mr. Brown. I am thinking here of commercial application.

Ms. Tolin. Right, commercial application. In fact, I spent yesterday in a meeting with the Users Advisory Board in Agriculture, at which there were several agencies represented at that meeting, and it became clear from our discussions that for some of the organisms FDA would be involved, if they were applied to food products, and certainly with animal vaccines and so forth, Veterinary Services clearly has jurisdiction over that, if it involves a plant pathogen or introduced organisms, APHIS would be involved, some aspects of the Food Safety Inspection Service in Agriculture would be involved, and EPA clearly would be involved in some of these under FIFRA or under TSCA.

Mr. Brown. That obviously will continue to be an item on your agenda as the area develops further?

Ms. Tolin. Yes; we haven't seen it yet, but I think what we would like to see is to keep the stream opened up so we can continue research, so that when an organism does get ready for commercial application, we will have had the basic research done on it and some information from actual test plots on what it does to the environment.

Mr. Brown. I am old enough to recall when the furor first arose preceding the first Asilomar Conference on DNA, there were many in Congress who were ready to start regulating right at that point. Fortunately wisdom prevailed, and we didn't move in that direction, but those kinds of forces are at work all the time.

Ms. Tolin. Yes; I think we are about at that stage, the same stage as we were with Asilomar now in terms of release. I think each organism has to be looked at on a case-by-case basis, and I am certainly not ready to approve releasing anything.

Mr. Brown. Thank you very much, Dr. Tolin, for your help on this.

Our next witness will be Dr. Allan Schmid, professor of agriculture economics at Michican State.

We welcome you, Dr. Schmid, and look forward to your testimony. You may proceed.

STATEMENT OF A. ALLAN SCHMID, PROFESSOR, DEPARTMENT OF AGRICULTURE ECONOMICS, MICHIGAN STATE UNIVERSITY

Mr. Schmid. Thank you, Mr. Chairman. My testimony is focused on a single issue. A theme is developing which suggests that the public sector largely restrict itself to basic research since the private sector can do the applied research and development of finished plants and micro-organisms to be sold to farmers and other consumers. What can we predict of the consequences of such a policy, were it to be followed?

The basic idea underlying this policy to guide division of responsibility between the public and private sector is that basic research is nonappropriable or has a too uncertain or distant a return in the market to justify private investment. On the other hand, the argument assumes that private property can be established in finished products via the patent system.

Let's examine whether the patent system can provide exclusivity sufficient to provide incentive for private research in the long run. Patent-like protection is provided by the 1970 Plant Variety Protection Act [PVPA]. The breeder receives an exclusive right to market a new variety. In practice, one breeder's variety is distinguished from another by a set of plant and seed characteristics such as hair on the leaf or stem, color and speckles on the seed, width of the seed crease, plant height, shape of the beard, or color of the chaff in a plant like wheat.

The problem is that it is possible for a competitor to take a new successful protected variety and breed into it a number of changes in these seed and plant characteristics without affecting the bottom line yield or disease resistance. This cosmetic breeding takes costly resources, but produces no additional bottom line performance. The cosmetically altered plant can in turn get protection under PVPA. One has an exclusive right to be sure, but it is so narrow as often to be of little value.

Competition from cosmetic copies could be eliminated if such small changes were made illegal by administrative or judicial rulings. But PVPA does not authorize such a concept. Congress could insert the concept of equivalency into PVPA which in principle means that not only are identical varieties infringements on the first owner's rights, but also slightly different varieties are infringements if judged to be equivalent. But this is not an easy concept to administer.

Plants—and micro-organisms—are extremely complex and there are often different genetic pathways to the same end. This means that it will be difficult to distinguish the purposeful cosmetically altered copy from the similar looking, but quite independently created, variety. So if Congress inserts the concept of equivalency into PVPA it will eliminate the copier and the independent discovery as well. This could result in very large monopoly returns for the first patent owner.

It would be very hard for the courts to distinguish copies from otherwise legitimate discoveries of alternate genetic pathways to a similar end result. This competitive balance is easier to maintain in the current mix of private and public breedings of finished varieties. The public breeder has no incentive for cosmetic breeding.

A new variety is not released until it is significantly different in bottom line yield—or whatever performance characteristic is desirable. Slight changes in appearance are worthless. Public release of finished varieties can keep private monopoly return in check in a way that the court's interpretation of "when is a small difference really different—or equivalent" can never do.

Micro-organisms have the same problems. After the 1980 Supreme Court ruling in *Diamond* v. *Chakrabarty* , micro-organisms can be patented under the regular patent act. That act includes the concept of equivalents—referred to as the requirement of nonobviousness. For example, if I patent a machine and you copy it except for the color of its paint, you are infringing on my patent. This distinction is not so easy for other aspects of machines and doubly difficult for living, evolving things.

The problem is illustrated by a conflict between Biogen Inc. and Genentech, Inc., who have competing claims to the invention of alpha interferon which shows promise in human medicine. Biogen filed for a Euorpean patent and shortly thereafter Genentech applied for a U.S. patent for a version which differed from Biogen's only in the composition of a string of two dozen amino acids out of hundreds.

Biogen admits that the version they are now using in clinical trials is slightly different from that described in its patent application. But Biogen arues that its improved variety and that of Genentech's are obviously improvements and really just equivalent to that of its original description.

No one has accused Genentech of copying or cosmetic alteration. But it is possible that still others could construct different organisms to produce the same product. If the issue comes to court, the tough question will be "How different is different?" If a narrow interpretation is made, the private sector may have less incentive to invest in research; but if a wider interpretation is made, independently discovered substitutes will be ruled out and profits could be immense.

Functional equivalents of exclusivity can sometimes be achieved via the characteristics of the product. For example, many micro-organisms are used to produce products which are in turn sold. The micro-organisms, however, stay safely on its creator's premises where its secrecy can be guarded—and protected legally as a trade secret. But this mode of protection is not available if the micro-organism has to be released into the environment in order to do its job, and then anyone can get it and reproduce it for their own use without buying more from its inventor.

A functional equivalent of exclusivity can also be achieved for some field crops. A hybrid variety does not breed true and the farmer can't save seed from this year's harvest to plant next year. Farmers don't compete with hybrid corn companies because of patent prohibitions but because the seed the farmer buys once can't be successfully saved and used again.

While this eliminates farmers as effective copiers and competitors, it will leaves the possibility that one breeding firm can copy from another. It is well known that commercial seed corn companies have similar varieties called by different names. Many of the parent lines are the same and came from public breeders. Even if they developed their own, it is hard to keep something a secret when it is grown in large fields or could be recovered by reverse engineering—breeding.

In fact, private breeders of hybrid seeds tolerate this copying because they have accomplished an oligopolistic market structure and have learned to share the market which is made quite lucrative once the farmer-saved seed substitute has been eliminated by the hybrid approach. So in some crops, hybridization and oligopoly can accomplish the exclusivity that patent law can not.

But this hybridization approach has its costs. Hybridization may not always be the best approach from a scientific or plant performance standpoint. The research agenda and breeding method gets determined by the needs of exclusivity rather than bottom line performance.

In conclusion, one can predict some of the consequences if the public sector were restricted to basic research, leaving the development of finished varieties of plants and micro-organisms to private investors.

First, cosmetic waste. Private firms, in order to get around a patent, are motivated to spend resources to make small alterations in existing plant varieties. These make no contribution to yield. Public breeders have less incentive to waste their time in this way and will not release a new variety unless it is significantly better than old varieties.

Second, choice of breeding method. Information and policing costs may bias the research approach to agricultural improvements. When patent protection fails, there is a bias toward hybrids and other genetic engineered degradations of second generation seeds. This limits the research agenda for reasons other than scientific and economic performance. Public breeders may be the only ones free to follow certain breeding methods which don't eliminate the farmer and consumers as competitors.

Third, allocation of productivity gains. It is difficult to arrange policy and institutions to achieve a given amount of research and at the same time assure that the returns to private research are reasonable. The policy must not only provide an incentive for investment, but also assure that the gains from new technology are reasonably distributed between private investor and the public.

What is reasonable is subjective and a policy choice for Congress to make. But it is hard to imagine that a private sector dependent on patents and their biological equivalents could, first, choose research methods and approaches on their own scientific and economic performance merits and second, allocate the benefits of productivity enhancement in a predictable fashion.

A narrow answer to "how different a claimed new variety must be from its predecessor" will protect from cosmetic copiers, but also eliminate independent discoveries of alternative genetic pathways to the same end. If the public presence in the release of finished varieties for farmer use is eliminated, it will mean that some breeding approaches would be ruled out, research resources would be wasted cosmetically, and the definition of equivalency—obviousness—would have to be so wide as to rule out independently derived substitutes.

Without prejudging the merits of the conflicting interests, we should think twice before public research is limited to the basic side of the ledger. In fact, Congress may wish to explore the possible expansion of the public institutions in the area of micro-organisms to provide the same balancing role they now play in plant varieties.

Thank you for your consideration.

Mr. **Brown**. Thank you very much, Dr. Schmid. I can't say that I understand the intricacies of everything you have said, but it seems to indicate that we now have another area of difficult policy choices as to where the boundary between public activities and private activities should be. There comes to my mind the parallel situation that we had with NASA where we wanted to commercialize communications satellites, and we did. But we found that because we stopped doing the basic research necessary to continue extending the technology, we ran into serious problems. I am not sure that we have solved that problem.

Indeed, you give us another one that seems to be even more difficult, but I think I understand the thrust of what you are saying, that is, that the public research institutions should maintain a healthy role in this area of breeding or production of new genetic organisms, in order to insure that the public gets the benefit of the new developments.

Mr. Roberts, do you have any quustions?

Mr. **Roberts**. Yes, thank you, Mr. Chairman.

I thank you, Dr. Schmid, for your fine statement. The chairman has provided the subcommittee members with an exellent briefing book prior to these hearings, and in that briefing book I notice that you mentioned there is a bovine growth hormone that would greatly increase milk production when widely used. I think you came up with a prediction that the use of this hormone could even amount to, what, 40 percent, a 40-percent reduction in dairy herds.

I think I asked Dr. Hardy what kind of research or developments in these fields could lead to a reduction in production costs. If farmers can, obviously, reduce that herd by 40 percent, you have got the answer. Where are you with that? Could I even bring that subject up for you to amplify on, in view of the lack of success with any dairy bills that we have had around here?

Mr. **Brown**. He is going to say how we can solve the surplus problems with increased productivity?

Mr. **Schmid**. I am familiar with this possible application in dairy, but it is one that I haven't myself worked on. I have worked mostly in the area of plant materials at this point. I recall to mind that Cornell University came up with those particular projections of the possibility that the increased productivity could mean that if we maintain present production we would need that much less in terms of dairy herd. It would certainly make the dairy problem that much worse.

Mr. **Roberts**. I don't want to beat a dead horse, or a dead cow in this case. My predecessor at one time introduced an amendment on the House floor to have the gestation period of the mother cow—we were having some problems with farm-price controls that were about to be slapped on by a consumer-oriented Congress that was about as far as the Congress had gone in terms of the law of supply and demand. But I did notice your work in that field, and since that was a large part of the efforts of your colleague from Cornell, I think I will yield back the balance of my time, Mr. Chairman.

Mr. **Brown**. I have no further questions, Mr. Schmid, although after I have had a chance to study your paper a little bit more, I may have some, in which case we may want to correspond with you about further elaboration. Thank you very much for your testimony.

Mr. SCHMID. Thank you.

Mr. BROWN. Our last witness this afternoon will be Dr. Charles Chambers who is the executive director of the American Institute of Biological Sciences.

You don't know how happy we are to see you, Dr. Chambers. You may introduce your colleague and present your testimony as you see fit.

STATEMENT OF CHARLES CHAMBERS, EXECUTIVE DIRECTOR, AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES, ACCOMPANIED BY ROBERT F. ACKER, AIBS REPRESENTATIVE, SOCIETY FOR INDUSTRIAL MICROBIOLOGY AND EXECUTIVE DIRECTOR, NATIONAL FOUNDATION FOR INFECTIOUS DISEASES

Mr. CHAMBERS. Thank you, Mr. Chairman, Mr. Roberts.

In light of the hour, let me summarize the written comments which will appear in the record and if I do gloss over anything which you feel is of particular interest, please feel free to raise it as questions.

For the record, my name is Charles Chambers. I am executive director of the American Institute of Biological Sciences. I am joined by Dr. Robert F. Acker, the AIBS representative of the Society for Industrial Microbiology.

Dr. Acker is also executive director of the National Foundation for Infectious Diseases and former executive director of the American Society for Microbiology.

AIBS is a national confederation of over 40 professional societies and research organizations in the life sciences.

Among all of these member groups are represented some 70,000 working biologists not only in the basic areas, but also in agriculture, environment, and in the medical sciences.

It is our great pleasure to appear before you today to present our views on biotechnology in agriculture and more specifically to address the biotechnology proposals of the Department of Agriculture.

Before I get into the points in the written statement, I would like to express our disappointment at the reductions that were just made in USDA's competitive grant program by the House Appropriations Committee, and those reductions affecting the plant genetics areas.

We hope you share this concern, Mr. Chairman, and that the biotechnology issues can be appropriated at the $28 million level requested by the administration.

Our institute is firmly convinced that it is important that we move ahead with this area of applications of biotechnology in agriculture.

Although the word may be new, the use of organisms is not new in industrial and agricultural processes, fermentation, of course, being a fairly obvious example.

However, recently the techniques of bioengineering have enabled us, for example, to develop a noninfectious vaccine for hoof and mouth disease, a vaccine which offers great potential for improving the health of livestock.

And yet there is a prelude to this whole area of biotechnology related to our natural resources and the role of endangered species in that world of natural resources.

Every species which becomes extinct, even very humble insects and microbes, reduces the available genetic material in which biotechnology can operate.

That is because biotechnology can't recombine. These basic genetic materials are important because it will be quite some time before we can synthesize functioning genetic structures in the laboratory. For these reasons, we are well advised to preserve the gene stocks, the natural mix habitats and to proceed with efforts to inventory and collect information on the genetic variety and diversity that exists not only in the United States, but in the world itself.

In thinking of the applications of biotechnology to agricuture, we are thinking in terms of new techniques, which enable us to be much more precise and achieve the desired goals in a much shorter period of time.

This area does hold great promise for the improvement of food supplies for a hungry world, but, as we all recognize, there are risks, and we must assure ourselves that the regulatory processes are clear, efficient, and effective, and we commend the efforts you have made, Mr. Chairman, with Congressman Dingell and Congressman Waxman, to request action by Dr. Keyworth in your recent correspondence to explore the regulatory paths and to bring some clarity and order to that, because we think that is very fundamental to achieving the benefits we can from this area.

The strength in all of the sciences that our country has enjoyed is a direct result of the reliance we have placed both as a Nation and the Government on the peer review process for judging scientific merits.

This has been adapted into the regulatory process at many different levels, and we consider that these are sound practices that can easily be enhanced and adjusted to facilitate the development of this great potential tool.

The NEPA legislation was passed after due consideration to accomplish important societal goals, and this process can easily be adapted and used to certify and review the activities that are proposed in the environmental release of genetically engineered materials.

As some of the other witnesses who have appeared before you today have noted, the scientific basis of use of biotechnology in agriculture introduces characteristics which are very marginal in the nature of the operation of the plant materials or even animal materials, and pose very little real risk of serious encroachments on the environment.

The plant varieties that are cultivated are very, very highly selected and highly specialized, and in fact we are running risks at this point of so overspecializing our agricultural varieties for yield and nutrition and what-not, that we are weakening their natural resistance to environmental stress, and we must look at those problems with equal concern for the enviromental risks that might exist.

For these reasons and others presented in the testimony, we do not feel that the genetic manipulation of domestic plants and animals poses matters of great environmental concern.

However, because we are operating at a qualitatively different level than we have in the past, with organisms that have the ability to reproduce themselves, we must have wide consultation and full use of the available scientific expertise in making decisions about what to use and the circumstances in which to use it.

The existing committees, both in NIH, the RAC advisory committees, and the AARC committee and USDA can continue to fulfill their stated role by having broader and more direct involvement by professional environmental and agricultural scientists and others who can look beyond the mere laboratories that might be involved in working with certain organisms under controlled situations.

The efforts being made by EPA to monitor and apply a constructive role in this field should be encouraged and should be used as a basis to enhance the administrative expertise of the genetic engineering regulatory and advisory committees.

By undergirding the government's regulatory process at the Federal, State, and local levels with the strength of scientific peer review, we can maintain the initiatives in basic plant genetic research supported by the National Science Foundation as well as the related applied areas in agriculture and other industrial and health areas.

Only through a vigorous program of competitive grants and support for modern instrumentation at both the basic and applied levels can we continue our scientific excellence and have the benefits accrue to our agricultural community.

The commendable professional relations which have existed between NSF and USDA especially in this plant genetic area should be encouraged, strengthened and perhaps even formalized to the entire agricultural community through the jointly funded projects, fellowship exchanges, pooled laboratory resources, etc.

While we must continue to maintain a broad-based network of research institutions and field stations to implement future scientific findings, the innovation and momentum which we have in the area of biotechnology in agriculture can only be assured if research proposals are sought from all qualified institutions and awards are made on the basis of merit and potential utility.

Our institute believes firmly in the agricultural potential of biotechnology and we are developing a natural food and agricultural policy forum, so that the policy deliberations in all the political, social and economic dimensions can be informed by the best scientific expertise available.

We support an expanded competitive grants program and renewal of equipment instrumentation at the institutional level and urge the development of proper guidelines for assessing the possible environmental impacts of experimentation in this area as rapidly as possible.

We commend the subcommittee for its foresight in addressing these issues, and Dr. Acker and I would be pleased to respond to questions you might have.

[The prepared statement of Mr. Chambers appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you very much, Dr. Chambers.

Dr. Chambers, an earlier witness, I think it was Dr. Rabin from the National Science Foundation, kind of gave us a historical picture of how the Federal Government has supported biological research, beginning maybe 30 years ago at NIH, and work being done at the National Science Foundation, particularly the more recent initiatives of the plant sciences, and then indicating the even more recent movement of the Department of Agriculture's research capabilities into this field.

I would like to have an enlightened comment from you or Dr. Acker about whether or not the Department of Agriculture is moving along a path which is adequately responsive to the burgeoning knowledge in this field, or whether we have some basis for criticizing it as being a little too slow.

I mention this because this was an element of debate on the floor this afternoon in which the distinguished chairman of the Appropriations Committee said we don't want to move too fast in this field and in which I tried to make the argument that we weren't moving fast enough.

Obviously, I would like to have you gentlemen with me, but perhaps it would be better if you were to give us your own opinion of this, if you can.

Mr. **Chambers**. Haste in scientific progress is always an element of great fascination and we had many discussions with representatives of both USDA and the Cooperative State Research Service, and the people in the National Science Foundation.

We do feel that there is an appropriate dichotomy of effort in those agencies and don't see at this point any bothersome redundancy or overlap.

The NSF initiative is addressed to some basic scientific issues, in cell genetics at the plant level which are much more sophisticated than we find in virtually all animal models.

The proposals which we have spoken about on other occasions in the Department of Agriculture in this area in particular lay in the competitive grants program and we have had opportunities to speak before the Appropriations Committee regarding our feeling that, given the vitality of this area of research, the use of the peer review and competitive grants approach in agriculture is absolutely essential to achieve as much progress and much rapid development as is possible.

Do you care to add to that?

Mr. **Acker**. Yes. If I may, I would say that I have witnessed over many years a struggle with this competitive grants program. It started slowly and I guess we could say it stayed at a slow pace for many, many years, and seems to have difficulty in gaining the recognition and gaining the funding that so many other competitive grants programs in other agencies enjoy.

I have never been sure why that was the case. I have never been quite sure why agriculture should not have the advantage of a competitive grants program of some magnitude with the competition and with the peer review.

It would seem to me to be a healthy process and a reasonably desirable way to go, and then in direct response to your earlier question, Mr. Chairman, I would say can you show me any examples really where research has gone too fast?

I can't think of any myself where there has been that much risk involved.

Mr. **Brown**. I think in part that question can only be answered as a function of what you perceive as the proposals in a particular field, what you might call the excitement, the potential, and we have different perceptions.

I have one perception; other Members of the Congress have other perceptions, quite obviously.

Mr. **Acker**. If I may, there is one area where there is a great deal of promise and we just mentioned during this testimony this afternoon from a number of sources the matter of the hoof and mouth disease vaccine sort of thing.

Well, I would say in the mix between veterinary medicine and human medicine there are tremendous opportunities there and one can learn from the other, and to put a burden on one and hold it up while another area can proceed does not seem to make sense to me.

Mr. **Brown**. As a part of our educational effort I inserted in the Congressional Record today five pages of promising research activities which were submitted by the Department of Agriculture to the Appropriations Committee. They were submitted after the hearings and I doubt if the chairman ever read them, but now somebody will read them I think, and it may change the perception a little bit with regard to the significance of these areas.

Dr. Chambers, you made reference in your paper on page four to the further development of the field of microbial ecology, which would appear to be of great importance in this matter of risk.

I haven't seen too much indication that there was any great development in this field of microbial ecology. Admittedly, I don't follow it too closely, but could you indicate to me how you see this as a developing field?

How do you characterize the activity that is occurring here? Is it expanding rapidly or am I missing something?

Mr. **Chambers**. One of the difficulties that we have encountered with assessing prudently the risks involved in the environmental release of genetically engineered materials, and in preparing objective and meaningful environmental impact statements, is the dearth of knowledge we have about microbial environmental activities.

The whole area of the soil fauna and its role in agriculture has been greatly overlooked, and we feel that not only does it have a role in agriculture, but because it is there in the environment, it is part of our environmental concerns also.

The degredations of pesticides by microbes and the increasingly higher toxic levels of traditional pesticides that would have to be applied, and the problems that exist in the food chain and whatnot, have not been that thoroughly looked at in terms of microbial ecology and we are saying here basically, and the reason it was presented here is that in order to make the sound judgments, in order to inform the regulatory process in the right way with the right type of environmental expertise, this is an area that needs some addition, so that we have a scientific basis.

Mr. ROBERTS. Thank you, Mr. Chairman and Dr. Chambers and Dr. Acker. Thank you for your comments. I am going to go in reverse order with your statement and say at the end of it here on page 5 this institute firmly believes that we are on the threshhold of a golden age in agriculture and biologically driven industrial process that you are forming up something called a national food and agricultural policy forum to insure that the highest quality of scientific expertise will continue to inform and assist the public policy making. And then you list everybody in terms of making these kinds of hard decisions we have to make.

What is the National Food and Agriculture Policy Forum and where are you in that process?

Mr. CHAMBERS. One of the major developments that drew our attention to this, of course, is the reauthorization of the farm legislation in the near future.

Mr. ROBERTS. I am not sure we have done that, but go ahead.

Mr. CHAMBERS. There are many actors in that situation and we have been impressed and I have been personally involved in the past with some work done in Washington with a so-called health forum and then with the Institute for Educational Leadership and the education forum in which there would be an opportunity for all parties to meet in a neutral setting to share ideas, to explore agendas, to discuss what the status of the scientific developments are so that policy positions which any group may want to develop on its own may be based on the best scientific information and the policy options that are developed would be realistic ones.

We are seeking independent private foundation support for such a forum at our institute in this area of food and agriculture which includes not only consumables, but also the fiber in products, too. We are at the stage of having to develop that proposal and are in negotiations with several foundations and we would then be a convener in the sense of a forum of interested parties who have ideas and positions to share and to explore with one another without having to have a formal special purpose agenda before them and can presumably leave this forum, as they have done with the health forum and the Institute for Educational Leadership forum through small group sessions, dinner meetings, 1 and 2-day workshps and what not, better informed about each other's views and more knowledgeable about, in our case, the current science base undergirding food and agricultural issues.

Mr. ROBERTS. But your recommendations would be going to appropriate committees and the Department of Agriculture prior to the consideration of the new farm bill. Is it in relation to a specific title or are you talking about recommendations across the board with regard to supply management or export policy?

Mr. CHAMBERS. This forum itself does not have as a purpose providing recommendations or taking policy positions on any of the titles or any of the areas. It is viewed as a vehicle for bringing together parties who have interests in all of the different aspects of it and exploring in a nonaligned neutral setting what their interests are and what the strengths and weaknesses of other positions are so that a stronger concensus can be built among those parties that do have special interests that they want to take.

Mr. Roberts. Congressman Charles Stenholm from Texas and myself had a similar idea or concept for a national agriculture forum which has the same title. To date we have not been as successful as we had hoped in regards to some of the key issues facing the farmer-stockman, but I certainly wish you well in your endeavor and hope that you would make available to all the interested parties at least whatever concensus sharing you are able to achieve.

Mr. Chambers. We would like very much to have participation by you and your colleagues and others who have expertise to bring to these discussions.

Mr. Roberts. I am sure if you issue an invitation to the chairman or other learned members of the subcommittee, we would be delighted to tell you all that we don't know or do know about various issues or subjects.

Mr. Chambers. Thank you, sir.

Mr. Roberts. On page 3, you are talking about the low level of risk from introducing new plant and animal life forms since they are all going to be a variant of a sort to the existing crops and I am wondering—I am always reminded as a lay person when I am reading all of your testimony about new bacterium strains or, say, introductions that that is on a different level and certainly a different level of understanding and perception on the part of the public.

I think it was some new form of bacteria that killed ET. I am not sure what other form of bacteria was used in various other space movies or science fiction movies. Sometimes they work to our advantage by killing the invader and sometimes they don't.

But I think the public perception is a lot like those old movies, Mr. Chairman, where the mad scientist is conducting an experiment on Lon Chaney and he runs a muck and the newspaper reporter who is the fair damsel in distress is saved by the young attorney and says something like: "There are some things in science that man was never intended to really go into or to know."

I don't think that school of thought should apply here, but I am wondering is there a separate review process in regard to this kind of public perception that you think we ought to undertake as opposed to the plant and the animal variety.

Mr. Chambers. We have thought about the relative risks involved and its relationship to the existing regulatory mechanisms which were, albeit developed, with different kinds of things in mind—toxic chemicals, fluids and things of that nature.

Our best judgment is that the strength that we have in building the benefits from science can best be done by informing the regulatory process with the scientific expertise we have, broadening the involvement of basically the laboratory scientist to include those with good environmental expertise and with the agricultural expertise and that that should be sufficient.

And that in the areas that NEPA applies the appropriate environmental impact reviews be made and that we can manage to reflect and show concern for the public safety and still achieve the progress in science development that we think is important.

We are not interested in putting the candle under a bushel and we are not interested in reverting to an age of know-nothingness and ignorance as you so well suggested, but that we do not see any overbearing need at this point for independent, self-defined and self-operating regulatory mechanism.

There are risks, but we don't characterize them as grave risks scientifically and we don't even characterize them as a terribly troublesome risk.

Mr. ROBERTS. Would you care to comment, Dr. Acker, on this? Do you have the same opinion?

Mr. ACKER. Yes, I think so. I think the forces at work are adequate for the challenges and I think that the history that the chairman mentioned a while ago has indicated that we have done really reasonably well by ourselves to keep the Andromeda strain at bay.

Mr. ROBERTS. I have no further questions, Mr. Chairman.

Mr. BROWN. Dr. Chambers, you made a passing reference on the last page of your statement to not only expanding the Competitive Grants Program, but you mentioned equipment and instrumentation which frequently gets overlooked. My recollection is that both NIH and NSF provide for equipment and instrumentation grants under some circumstances.

I don't recall exactly how much they provide. I presume that when the Department of Agriculture does enthusiastically get into a Competitive Grants Program that it would be desirable to include a component looking to the upgrading of equipment and instrumentation?

Mr. CHAMBERS. Very much so. NIH and NSF can't do it all. There are some new instrumentation requirements in this area of biotechnology, but even more importantly as you are well aware, we have gone through a very dry period of drought at the institutional level and we have got a lot of old equipment that just needs to be brought up to date to keep not only these scientific research initiatives, but the broad scientific effort itself underway.

Mr. BROWN. It seems to be a characteristic of science; that is, as it becomes more advanced and comprehensive, it does require larger and more expensive items of equipment. I suppose biologists need big computers just like anybody else.

Mr. CHAMBERS. They are learning that there are some very fundamental uses of computers especially in the biotechnology area not only for analysis, but for automated production techniques in the laboratory.

Mr. BROWN. All right. Well we thank you very much, both of you, for your presentation and it will be very helpful to us and we do hope that you will keep us in touch with your efforts to organize this food and agricultural policy forum as we approach the renewal of the farm bill next year.

Mr. CHAMBERS. Thank you, sir.

Mr. ACKER. Thank you very much.

Mr. BROWN. The subcommittee will be adjourned.

[Whereupon, at 5:45 p.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

Statement of Dr. Bill R. Baumgardt
Director, Indiana Agricultural Experiment Station
Associate Dean of Agriculture
Purdue University
West Lafayette, Indiana

INTRODUCTION

Mr. Chairman, my name is Bill R. Baumgardt. I am Director of the Indiana Agricultural Experiment Station and Associate Dean of Agriculture at Purdue University, West Lafayette, Indiana. In related professional activities, it is my pleasure to serve as President-elect of the American Dairy Science Association, and Chairman of the Board-elect of the Agricultural Research Institute. I am a member of the National Association of State Universities and Land Grant Colleges - NASULGC (Division of Agriculture) Committee on Biotechnology and I represent that Committee here today.

I am pleased to have an opportunity to address issues of concern to your Committee. In my testimony, I wish to to address the following components of the issue: (1) Concepts developed by the NASULGC Committee on Biotechnology, (2) Public and private roles, and (3) Structure of the USDA Grants Program for Biotechnology.

NASULGC COMMITTEE ON BIOTECHNOLOGY

The NASULGC (Division of Agriculture) Committee on Biotechnology includes individuals with varing degrees of administrative responsibility for agricultural research and education programs in land-grant universities and attorneys versed in agricultural law and relavant tax and patent laws and codes. As a committee we may have done more thinking and analysis on the issue of biotechnology and agriculture than any other group. The process in fact, started long before formalization of the Committee. Interests of the Committee represent a natural development of the planning, coordination and research function of the national endowment we all know as the Land-Grant system. We have been about this science from its beginning. A sub-group of the ultimate committee took leadership to focus attention on the potential of the new biotechnologies for agriculture. Another sub-group met under the initiating leadership of the Texas Agricultural Experiment Station to consider appropriate means of interaction between the public AES system and private industry including means of funding research and patenting and ownership issues. The NASULGC Biotechnology was officially established in April, 1982. Major thrusts have been and continue to be dealt with by sub-committees on: (a) Land-Grant Institutions and Biotechnology, (b) Education and Manpower needs, (c) Funding and University/ Industry Relationship, (d) National Program Leadership and Development, and (e) Social/Ethical Issues. Formal progress reports were issued in November 1982[1] and 1983[2] with frequent release and sharing of component drafts for review and comments. Most of the data and Committee efforts that I will describe in this testimony today have been taken from those reports.

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PUBLIC AND PRIVATE ROLES

What is emerging as an appropriate pattern, is that of a mix of funding sources and arrangements designed to capitalize on the vast opportunities for biotechnology in agriculture.

In general, the public sector research program has lead responsibility: (a) for much (but not all) of the basic research, (b) for educating and training of scientists, and (c) to ensure application to a wide array of needed plants, animals and products, many of which offer little profit incentive to the private sector. On the other hand, the private sector has responsibility for much (but not all) of the applied research and development leading to marketable products, plus they must have prompt access to basic research results. Several of the major industrial organizations have established significant in-house research programs in biotechnology related to agriculture. Many of these same companies plus many other (usually smaller) companies also sponsor research grants or contracts with universities to gain that quick access and window on the cutting edge of science. Much of the industrial sponsorship of biotechnology research remains on a one company, one university contractual arrangement. However, I perceive a growing interest in the "consortia concept" where a group of companies jointly support a basic research program at a university, (or universities) with the companies sharing in the findings on a timely basis and also sharing in access to the scientists being trained.

I believe it is in the best interest of the public that much of the basic research in molecular biology and biotechnology be done in the public sector and and that it be supported by public funds. This will help ensure first of all,

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that information gained on the most fundamental and widely applicable principles of biology, can be made available to all of the scientific community for appropriate exploitation; and secondly, public funding will ensure that a part of the basic research is targeted to agricultural problems or thrusts which are truly in the public interest.

Base support for public programs is provided most appropriately by the federal and state governments. Perhaps the best example of this lies in the federal-state partnership created by the Hatch Act and made real in the state agricultural experiment stations (SAES). In 1981, the states provided $4.06 of state funds for every $1.00 of Hatch funds.[3] These appropriations form a base support in terms of facilities and scientists in a wide array of disciplines. They provide for continuity of the research effort, attention to important problems demanding a long term commitment, and this base funding provides the opportunity for the new, innovative ideas to be pursued. It is this base program that enabled the State Agricultural Experiment Stations to initiate their agricultural biotechnology programs that had 283 faculty FTE's and 579 projects ongoing in 1982.[2] The Biotechnology Committee obtained similar information about the USDA-Agricultural Research Service (ARS) programs in biotechnological research from the ARS administrator. The ARS reported 94 biotechnology projects with an FTE commitment of 78 scientists.

Our committee also has surveyed member institutions of the National Association of State Universities and Land Grant Colleges to determine their capability in the area of biotechnological research and education. The questionnaire was similar to the one used with SAES and ARS. Responses are still being received and we hope to have this information summarized and evaluated by fall of 1984.

4-a

Earlier I referred to a mix of funding sources and arrangements. For example, the SAES are spending over $40 million for biotechnological research. The percentage distribution of funds by source was State 39%, Federal 48% and Private 13%. Our Committee has been active in several areas to help foster an expansion of appropriate private funding of biotechnological research in SAES and universities. These efforts include chapters and draft papers on:

- Policy considerations for various University/Industry relationships
- Tax considerations for various funding arrangements
- Information on appropriate use of patents and Certificates of Plant Variety Protection
- Guidelines for the development of a University/Industry Research Contract
- Faculty consulting in the private sector

Overall, the Committee has provided information, raised concerns, suggested guidelines, and in general heightened interest and awareness of both public and private providers of funds for biotechnological research. More and more state legislatures are appropriating special funds to support such research. In many cases, these public funds are used to stimulate private matching funds. We would be pleased to provide some specific examples to your Committee, Mr. Chairman, if that would be desired.

5 -

STRUCTURE OF THE USDA GRANTS

PROGRAM FOR BIOTECHNOLOGY

Our NASULGC Biotechnology Committee has evaluated both the need for research support and the form of that support very carefully. We approached the subject by surveying and analyzing what effort was underway, what "scientist power" was available as well as determining the areas of research with the greatest opportunity for exploitation and advancement of agriculture. (Note the listing on pages 22-27 of the Committee Progress Report II, 1983[2] as well as other sources[4,5]). We made estimates of the need for equipment and the need for scientists to work on biotechnology within the land-grant system. We then constructed a set of competitive grants programs which would excite the development of the most advanced science, ---things that are on the cutting edge ---whether they related to an animal cell system, a plant cell system or a microbial cell system. The key issue is to excite the kinds of cutting edge science that can be brought to bear on the most significant biological problems facing agriculture.

To bring about this kind of booster-thrust to the system we outlined a minimal program including research grants, fellowships, and equipment grants. We suggested an initial budget of $70 million to be distributed as follows:

Research Grants	Million $
Individual research grants ($100-125,000 1 yr., for at least 3 yrs.)	24.0
Multidisciplinary research grants (at least $200,000 per yr. for at least 5 yrs.)	16.0
Young investigator incentive awards	1.0

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Fellowships	
Pre-doctoral fellowships	1.2
Post-doctoral fellowships	2.8
Senior post-doctoral fellowships	1.0
Equipment grants	24.0
Total	$70.0

An annual base budget of $70 million would provide funding assistance for only a small portion of the research programs and education efforts. Based on our survey of the present faculty effort in biotechnology in just the SAES [1,2], the $70 million would provide research support for only 23% of the faculty, 6% of the pre-doctoral students, and 8% of the new faculty at the desirable award levels. Adding the faculty and students from outside the SAES group, of course, makes the fraction of support become even lower. This low fraction of potential support demonstrates clearly the need for funds and assures there will be strong competition for the grants.

We stressed that for this program to have the desired impact, it must be added to existing research and education programs, not be a replacement for or redirection of current programs, which are essential in their own right. The program would be administered by the USDA in a manner compatible with the competitive grants program. It should be open to all scientists in public and private universities, research institutes and government agencies, have peer-review panels, a program council of distinguished scientists with a broad view of basic research for agriculture, a program director drawn from the academic community on a rotating basis, and a permanent associate director expert in the field, responsible for effective administration of the program.

I would like to address briefly some specific questions which apparently have been raised about sub-sets of this program. First, what about the need and structure of a multidisciplinary grants program? (For the moment I shall not belabor the distinction between multidisciplinary and interdisciplinary research. Suffice it to say that in both cases, scientists from several disciplines are involved in problems with mutual goals^6). It is the Committee's view that multidisciplinary research must be encouraged because so many of the necessary research goals in biotechnology for agriculture require the collaboration of several disciplines for optimum progress. All of the Agricultural Experiment Stations (AES) are multidisciplinary and many of them include basic-science departments such as biochemistry. If not within the AES, the various disciplines needed would be represented on land grant university campuses. We feel there is a place for a component similar to that in the McKnight Foundation program which will be addressed later in this hearing.

Another question has been asked about the impact of small short term competitive grants awards. Our committee recommends funding the individual research grants at a level of $100 - 125,000/year (including indirect costs) for a term of at least three years. These levels and durations are within recommended guidelines of NIH, NSF as well as independent estimates by SAES directors. Currently USDA competitive grants in plant science and NSF grants in biology are being funded at lower levels. These less than optimum levels of funding are practiced by concluding that it is preferable to provide some funding to more of the excellent proposals rather than fully funding of only a few. We believe that to optimize the effects the USDA Biotechnology proposal, low award levels must be avoided.

Some may consider the $100-125,000 per year level for 3 years to be "small and short term." However, it must be emphasized that there is a base funding undergirding such programs at SAES and land grant institutions. The proposed grants provide a spike thrust which will organize and concentrate efforts in important research areas. Furthermore, the USDA program must be both enlarged and continued so that the most productive projects can be renewed beyond the initial period.

In this context, Mr. Chairman, I wish to point out that we believe it is essential to remove the $50 million authorization cap on competitive grants that is in the current version of Title XIV of the "Farm Bill". This cap forced the competitive grants biotechnology program to be proposed in the FY 85 Budget at a level much below the optimum level. Furthermore, we perceive that the competitive grants component of the USDA research budget is one which should be greatly enlarged in program areas and in total funds made available in these next fiscal years.

Let me briefly address another point raised in the draft charter for these hearings, "The greatest gains from biotechnology will come when scientists in traditional disciplines are trained to understand the potential contribution of biotechnology to their work, and when scientists in the new biotechnology disciplines understand how their efforts contribute to the existing knowledge base. The USDA budget material emphasizes the Department's ability to link the new effort to the existing knowledge base." Mr. Chairman, on behalf of the Biotechnology Committee, I want to reassure your committee that this linkage is already well underway in the State Agricultural Experiment Stations. One of the great strengths of the system is the inherent array of the disciplines and the built-in linkages with an effective technology transfer system in the Cooperative Extension Service. Furthermore, we want to assure you that the Biotechnology Committee recognized and understood the need to continually add to the linkages between basic molecular biology, genetics and breeding --- for both plant and animal systems. This can be accomplished within our proposed programs and within the USDA competitive grants program. This is one example of the special need for multidisciplinary research grants.

Finally and perhaps most importantly, I wish to present my (and I believe the Biotechnology Committee's) perspective on how the FY 1985 biotechnology increase could be most effectively utilized. First, some comments on the magnitude of that increase. The budget as originally presented included $28.5 million for the program in competitive grants. We perceive that $28.5 million level was chosen because that was all the space left under the current $50 million authorization cap for competitive grants. You will recall that our recommendation was for $70 million. Mr. Chairman, we firmly believe that the full $28.5 million must be made available if the United States agricultural and food production system is to stay on the forefront of scientific and technological developments --- to stay on the cutting edge --- to regain our economic competitive advantage in world markets.

Second, given this much reduced level of funding ($28.5 million rather than $70 million) we recommend that emphasis be placed on the Research Grants categories. The ratio between individual and multidisciplinary grants should be kept approximately as in our Committee's original proposal. (That is about a 60:40 split or $17.1 million plus $11.4 million.) Inclusion of graduate students and post-doctorals in the grants should be encouraged. This would help the tremendous need to educate more scientists in biotechnology for agriculture. The best training of practicing scientists can be achieved by participation in research programs in cutting edge science, being led by recognized scholars in the area. Further, because of the critical need for equipment, we urge that adequate consideration be given to including some significant equipment requests when the need is well documented and included in a high quality proposal.

Beyond this adjustment, we recommend implementation in accord with the carefully developed scientifically sound proposal originally made by our committee.[2]

In summary fashion, that is:

a) Program areas to establish a thorough understanding of the genetics, biochemistry, physiology, metabolic control, and developmental biology of plants, animals and microbes---to provide the basic scientific knowledge needed for the development and application of the new biotechnological research capability to agriculture and food. Its primary emphasis should be to enhance understanding of basic biological principles. The program also should focus on the basic approaches within the context of meeting the needs for tomorrow's food and agriculture.

b) Subject areas in both individual and multidisciplinary research grant programs should be those where there is greatest need:

(1) Structure, function, and organization of plant, animal, and microbial genomes.
(2) Transfer, expression, and regulation of individual genes and gene systems.
(3) Genetic and molecular control of growth, development, and resistance to physical and biological stress.

A group of leading scientists should be brought in to lay out the specific criteria for these subject areas.

c) Operational procedures should include:
   (1) All grants should be investigator-initiated, peer reviewed, and awarded on a competitive-merit basis.
   (2) The program should cover the basic principles, utilizing plant, animal and microbial systems.
   (3) The program should be open to all scientists in public and private universities, SAES, research institutes, and government laboratories.

Mr. Chairman, we thank you and your Committee for your interest. With the foundation which will be laid by this enlightened program, we will have within our power, the capacity to ensure the leadership of the American agricultural and food system and the security of the world's food supply.

This completes my prepared statement. I will be pleased to respond to any questions you may have.

(Attachment follows:)

Footnotes

1. Emerging Biotechnologies in Agriculture: Issues and Policies. Progress Report, November 1982 Division of Agriculture, Committee on Biotechnology. Division of Agriculture, NASULGC, 1 Dupont Circle, Washington, D.C.

2. Emerging Biotechnologies in Agriculture: Issues and Policies. Progress Report II, November 1983. Division of Agriculture, Committee on Biotechnology, NASULGC, 1 Dupont Circle, Washington, D.C.

3. Federal Agricultural Research Funding: Issues and Concerns. Report by the U.S. General Accounting Office, October 20, 1983.

4. Biotechnology, in Science Vol 219, No. 4585, Feb. 11, 1983. pp 611-746 devoted to articles on Biotechnology.

5. Report of the Briefing Panel on Agricultural Research. Committee on Science, Engineering and Public Policy. National Academy of Sciences, 1983.

6. Enabling Interdisciplinary Research: Perspectives from Agriculture, Forestry, and Home Economics. M. G. Russell, editor. Misc. Publ. 19-1982. A.E.S., University of Minnesota.

STATEMENT OF
DR. ROBERT RABIN
ACTING ASSISTANT DIRECTOR FOR
BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES
NATIONAL SCIENCE FOUNDATION

MR. CHAIRMAN:

MY NAME IS ROBERT RABIN. I AM THE ACTING ASSISTANT DIRECTOR FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES AT THE NATIONAL SCIENCE FOUNDATION. I AM APPEARING AT THE REQUEST OF DR. EDWARD A. KNAPP, DIRECTOR OF THE FOUNDATION, IN RESPONSE TO YOUR INVITATION TO TESTIFY AT THIS HEARING.

THIS IS AN OPPORTUNITY TO INTRODUCE TO YOU DR. DAVID T. KINGSBURY. HE IS THE PRESIDENT'S NOMINEE FOR ASSISTANT DIRECTOR, BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES (BBS) AT NSF. DR. KINGSBURY IS PROFESSOR OF MEDICAL MICROBIOLOGY AND VIROLOGY AT THE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF CALIFORNIA, BERKELEY. ALSO, HE IS SCIENTIFIC DIRECTOR, NAVAL BIOSCIENCES LABORATORY, AT THE UNIVERSITY. UPON HIS ASSUMPTION OF THE ASSISTANT DIRECTORSHIP AT NSF, I WILL RESUME MY DUTIES AS DEPUTY ASSISTANT DIRECTOR FOR BBS.

THIS SUBCOMMITTEE HAS PERFORMED AN OUTSTANDING SERVICE BY CONDUCTING EXTENSIVE HEARINGS SINCE 1982 ON CRITICAL ISSUES IN

AGRICULTURAL SCIENCE AND EDUCATION. THE NATIONAL SCIENCE FOUNDATION AND THE NATIONAL SCIENCE BOARD HAVE BEEN PLEASED TO PARTICIPATE IN YOUR EFFORTS.

I AM PARTICULARLY PLEASED ALSO TO ACKNOWLEDGE THE COOPERATION BETWEEN THE USDA AND NSF: IT IS STRONG, CONSTANT, AND PRODUCTIVE. IT HAS INCLUDED PARTICIPATION IN DOMESTIC AND INTERNATIONAL INTERAGENCY COMMITTEES, JOINT PLANNING AND FUNDING OF RESEARCH, AND JOINT PARTICIPATION IN SYMPOSIA, REVIEW PANELS, AND PUBLICATIONS.

COOPERATION BETWEEN OUR AGENCIES BEGAN AS EARLY AS 1951, SOON AFTER NSF WAS ESTABLISHED. AT THAT TIME, S.B. FRACKER, ASSISTANT TO THE ADMINISTRATOR OF THE AGRICULTURAL RESEARCH SERVICE, ASKED ALAN WATERMAN, NSF'S DIRECTOR, IF IT WOULD BE APPROPRIATE FOR USDA TO SEND RESEARCH PROPOSALS ON PHOTOSYNTHESIS TO NSF TO BE REVIEWED AND CONSIDERED FOR FUNDING. DR. WATERMAN WELCOMED THIS CHANCE; INTERACTIONS BETWEEN STAFF THAT BEGAN SHORTLY THEREAFTER STARTED A LONG, FRUITFUL RELATIONSHIP THAT WAS TO INCREASE CONSIDERABLY. IN 1976, NSF PLAYED A MAJOR ROLE IN HELPING USDA SET UP ITS COMPETITIVE RESEARCH GRANTS PROGRAM, AND BOTH AGENCIES CONTINUE TO WORK TOGETHER TO INSURE THE SUCCESS OF THIS RELATIVELY NEW USDA PROGRAM.

I BELIEVE THIS MORE RECENT HISTORY HAS BEEN REVIEWED BY THIS SUBCOMMITTEE AND BY THE HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

DURING DR. ELOISE CLARK'S TENURE AS ASSISTANT DIRECTOR OF NSF. IT IS FITTING TO CLOSE MY REMARKS ON THIS ASPECT BY REMINDING THE SUBCOMMITTEE THAT DR. WENDELL L. ROELOFS WAS AWARDED THE 1982 WOLF PRIZE IN AGRICULTURE FOR HIS WORK ON PHEROMONES AND THEIR PRACTICAL USE IN INSECT CONTROL. DR. ROELOFS' RESEARCH WAS SUPPORTED BY NSF.

MR. CHAIRMAN, LET ME TURN TO A CENTRAL ISSUE OF THESE HEARINGS: BIOTECHNOLOGY. YOU WILL RECALL THE TESTIMONY OF DR. CHARLES E. HESS LAST FEBRUARY 7 BEFORE THIS SUBCOMMITTEE WHEN HE APPEARED AS A MEMBER OF THE NATIONAL SCIENCE BOARD. HE SPOKE STRONGLY IN SUPPORT OF THE NEW BIOTECHNOLOGY INITIATIVE PROPOSED IN THE FY 1985 BUDGET FOR USDA. HE WAS REFLECTING BOTH HIS PERSONAL AND NSF'S CONCERNS FOR THE WELFARE OF THIS INITIATIVE IN ITS JOURNEY THROUGH THE CONGRESSIONAL BUDGET HEARINGS.

I SHOULD APPRISE YOU OF EVENTS SINCE THEN IN WHICH DR. HESS HAS FIGURED. IN LATE FEBRUARY, THE NATIONAL SCIENCE BOARD AGREED TO DEDICATE A SUBSTANTIAL PART OF ITS JUNE MEETING TO A DISCUSSION OF BIOTECHNOLOGY. IT APPOINTED DR. HESS TO LEAD A TASK GROUP OF THE BOARD IN DEVELOPING THE ISSUES AND BACKGROUND PAPERS. I HAVE BEEN PRIVILEGED, IN LEADING NSF'S STAFF IN SUPPORT OF THIS EFFORT, TO WORK CLOSELY WITH DR. HESS. ALSO, THE BOARD RECENTLY ELECTED HIM AS ITS VICE CHAIRMAN. I BELIEVE THAT THESE ACTIONS WILL HAVE A SALUTARY EFFECT IN CONTINUING WHAT HAS BEEN A MUTUALLY ADVANTAGEOUS RELATIONSHIP BETWEEN NSF AND THE USDA.

THE BOARD'S DELIBERATION ON BIOTECHNOLOGY WILL CENTER ON SEVERAL TOPICS: (1) ITS RELEVANCE TO OUR NATIONAL INTERESTS; (2) THE MAJOR NATIONAL NEEDS TO SUPPORT BIOTECHNOLOGY; (3) THE ROLE OF THE FEDERAL GOVERNMENT, PARTICULARLY IN BASIC AND APPLIED RESEARCH; AND (4) SPECIFICALLY, NSF'S ROLE BOTH CURRENT AND FUTURE. THE BOARD'S DISCUSSION WITH US AND THEIR RECOMMENDATIONS WILL HAVE A VERY USEFUL INFLUENCE IN SHAPING THE FOUNDATION'S POLICIES AND ACTIVITIES.

MR. CHAIRMAN, BIOTECHNOLOGY IS NOT A NEW HUMAN ACTIVITY, AND IT IS NOT THE PROVINCE OF A SINGLE FEDERAL AGENCY. MANKIND HAS EMPLOYED IT TO FERMENT GRAIN TO PRODUCE INDUSTRIAL ALCOHOL, TO MAKE BREAD, TO CREATE VACCINES, AND TO PRODUCE PENICILLIN. THESE ARE EXAMPLES OF WHAT IS CALLED "OLD BIOTECHNOLOGY." NEW BIOTECHNOLOGY, HOWEVER, IS THE CHILD OF FEDERAL RESEARCH SUPPORT MAINLY IN OUR COLLEGES AND UNIVERSITIES. IT CONTINUES TO BE NURTURED BY THE FUNDS FROM NSF AND AGENCIES WHOSE MISSIONS ARE ROOTED IN PUBLIC HEALTH, AGRICULTURE AND ENERGY, AND TO A MUCH LESSER EXTENT, DEFENSE. THE FAITH OF THE CONGRESS IN DEDICATING SUBSTANTIAL FUNDING FOR RESEARCH FROM THE EARLY 1950'S ONWARD IS BEING REWARDED AND REINFORCED BY THE FREQUENCY OF RESULTS AND THE PROMISING POTENTIAL FOR INCREASED NATIONAL INDUSTRIAL ECONOMIC GROWTH.

NEW BIOTECHNOLOGY COMPRISES THREE PRIMARY GROUPS OF TECHNOLOGIES:

- --RECOMBINANT DNA TECHNOLOGY
- --CELL FUSION TECHNOLOGY
    - •HYBRIDOMA (MONOCLONAL ANTIBODY) TECHNOLOGY
    - •SOMATIC CELL GENETICS
- --BIOPROCESS ENGINEERING

THE APPLICATION OF THESE TO AGRICULTURE IS IN ITS INFANCY, BUT THEIR USE HAS BEEN ENTICINGLY REFERRED TO IN THE RECENT REPORT TO THE CONGRESS BY SECRETARY JOHN R. BLOCK WITH WHICH YOU ARE FAMILIAR: "NEEDS ASSESSMENT FOR THE FOOD AND AGRICULTURAL SCIENCES."

HISTORICALLY NSF HAS PROVIDED FINANCIAL SUPPORT TO THE STUDY IN PLANT AND ANIMAL SYSTEMS OF FUNDAMENTAL GENETICS, CELL PHYSIOLOGY, CELL CULTURE BIOLOGY, NUCLEIC ACID CHEMISTRY, BIOCHEMICAL ENGINEERING, AND MICROBIAL PROCESS ENGINEERING. FINDINGS FROM THESE AREAS HAVE PROVIDED THE BASES FOR THE EXCITING TECHNOLOGIES OF TODAY. ONE OF THE MOST VALUABLE APPLICATIONS OF BIOTECHNOLOGY THAT ALSO RECEIVES SUPPORT IS THE USE OF GENE SPLICING, CELL FUSION AND BIOPROCESS ENGINEERING METHODS AS TOOLS IN RESEARCH PROJECTS THEMSELVES. THEY ARE OFTEN CRITICAL TO EXPERIMENTS IN BIOLOGY, CHEMISTRY AND ENGINEERING.

THIS LAST POINT DESERVES EMPHASIS: SIMPLY HAVING A COLLECTION OF TECHNIQUES UTILIZING THE MANIPULATION OF DNA OR THE FUSION OF CELLS DOES NOT CONSTITUTE AN ESTABLISHED TECHNOLOGY WHICH REQUIRES ONLY AN OCCASIONAL FINE TUNING. DEFICIENCIES IN OUR KNOWLEDGE IMPEDE THE CONTINUED DEVELOPMENTS OF THESE TECHNIQUES FOR USE IN BASIC SCIENCE AND THEIR ULTIMATE COMMERCIAL APPLICATION. THUS, IN PROVIDING A POWERFUL SET OF TOOLS FOR BIOLOGICAL RESEARCH, BIOTECHNOLOGY HAS ACCELERATED SCIENTIFIC DISCOVERY IN AREAS WHERE THE COMMERCIAL APPLICATION OF THE TECHNOLOGY ITSELF IS NOT IMMEDIATELY OBVIOUS. THE TRADITIONAL ROLE OF NSF IN THE SUPPORT OF BASIC RESEARCH HAS BEEN TO ENCOURAGE NEW IDEAS AND APPROACHES PROPOSED BY THE SCIENTIFIC COMMUNITY. GENERALLY, REGARD FOR THEIR APPLICABILITY TO A PRACTICAL COMMERCIAL PROBLEM HAS BEEN OF SECONDARY IMPORTANCE.

IT WAS BECAUSE THE COMMUNITY THAT NSF SERVES SAW GREAT OPPORTUNITIES IN THE PLANT SCIENCES--TO BETTER UNDERSTAND STRUCTURE AND FUNCTION AT THE MOLECULAR LEVEL WITH "NEW BIOTECHNOLOGY" AND SOPHISTICATED INSTRUMENTATION--THAT WE EMBARKED ON A SUBSTANTIAL EFFORT TO CONVINCE THE BOARD, OUR MANAGEMENT, THE ADMINISTRATION AND THE CONGRESS TO INCREASE OUR ABILITY TO SUPPORT THIS WORK. ACTING ON ITS CONVICTION THAT PLANT SCIENCE COULD BENEFIT FROM THE REMARKABLE ADVANCES IN MOLECULAR BIOLOGY EVIDENT FROM STUDIES OF VIRUSES, BACTERIA AND

ANIMAL CELLS, THE BOARD RECOMMENDED AND MANAGEMENT AGREED TO SUBSTANTIAL INCREASES IN THE FOUNDATION'S BUDGET. BETWEEN FY 1983 AND (THE REQUEST FOR) FY 1985, THE BUDGET HAS INCREASED 36 PERCENT FOR RESEARCH IN PLANT SCIENCE.

MR. CHAIRMAN, IF THE CONGRESS APPROPRIATES FY 1985 FUNDS FOR NSF'S USE IN THE PLANT SCIENCES AT THE ADMINISTRATION'S REQUESTED LEVEL, WE ESTIMATE THAT WE WILL OBLIGATE $58 MILLION NEXT YEAR. THIS IS A 70 PERCENT INCREASE OVER THE FUNDING IN FY 1981 WHICH WAS $34 MILLION. BUT NOT ALL OF THIS INCREASE IS ALLOCATED TO PLANT MOLECULAR BIOLOGY. ABOUT 43 PERCENT (OR $25 MILLION) WILL SUPPORT RESEARCH IN ECOLOGY, SYSTEMATIC BIOLOGY, POPULATION BIOLOGY AND ECOSYSTEM STUDIES.

LAST YEAR THE FOUNDATION HELD ITS FIRST COMPETITION FOR POSTDOCTORAL FELLOWSHIPS IN PLANT BIOLOGY. THE NEW PROGRAM WAS INAUGURATED TO ENHANCE BROAD INTERDISCIPLINARY APPROACHES TO PLANT RESEARCH. IT RESPONDED TO THE NEED (1) TO CATALYZE MORE EXTENSIVE USE IN PLANT RESEARCH OF THE TECHNIQUES DEVELOPED IN RESEARCH WITH MICROBIAL AND ANIMAL SYSTEMS, AND (2) TO PROVIDE SUPPORT FOR YOUNG SCIENTISTS IN THESE MOST PROMISING AREAS OF RESEARCH IN WHICH THE DEMAND FOR SCIENTISTS IS INCREASING.

IN 1983, FELLOWSHIPS WERE AWARDED TO 24 YOUNG SCIENTISTS WHO HAD EARNED THE DOCTORATE DEGREE AFTER JANUARY 1, 1980. THESE

WERE SELECTED FROM 194 APPLICANTS. THE NEW FELLOWS INCLUDED 14 WOMEN. IN 1984, IN THE COMPETITION RECENTLY CONCLUDED, 20 FELLOWS, INCLUDING 5 WOMEN, WERE SELECTED FROM 128 APPLICANTS.

THE FELLOWSHIPS ARE FOR ONE YEAR AND ARE RENEWABLE FOR AN ADDITIONAL YEAR. EACH FELLOW IS FREE TO SELECT AN AMERICAN OR FOREIGN INSTITUTION FOR FURTHER STUDY. AMONG THE 44 FELLOWS SELECTED, ONLY EIGHT CHOSE TO WORK ABROAD AND, OF THE LATTER, FIVE ELECTED TO STUDY AT THE SUPERB NATIONAL PLANT LABORATORIES IN AUSTRALIA. PLANT GENETICS HAS BEEN THE MOST POPULAR FIELD OF STUDY AMONG THE DISCIPLINES IN PHYSIOLOGY, CELLULAR AND MOLECULAR BIOLOGY.

NOW I WOULD LIKE TO BRIEFLY NOTE SOME FINDINGS OF A SURVEY SPONSORED BY NSF. IT WAS CONDUCTED BY THE HIGHER EDUCATION PANEL OF THE AMERICAN COUNCIL ON EDUCATION. THE CONCLUSIONS ARE PRELIMINARY AND MAY BE REVISED LATER. LAST AUTUMN, 210 DOCTORATE-GRANTING INSTITUTIONS WERE QUESTIONED ABOUT PLANT SCIENCE PROGRAMS, AND 90 PERCENT RESPONDED: 165 REPORTED GRADUATE PROGRAMS IN PLANT BIOLOGY.

THESE INSTITUTIONS RECEIVED ABOUT $200 MILLION IN RESEARCH SUPPORT. HALF CAME FROM THE FEDERAL GOVERNMENT; 34 PERCENT CAME FROM STATE GOVERNMENTS. INDUSTRIAL SOURCES PROVIDED ONLY 10 PERCENT.

APPROXIMATELY 8000 GRADUATE STUDENTS WERE ACCOUNTED FOR IN THE SURVEY. FEDERAL RESEARCH GRANTS SUPPORTED ONLY 20 PERCENT OF THEM, AND ONLY 3 PERCENT HAD FEDERAL FELLOWSHIPS. STATE GOVERNMENTS SUPPORTED 12 PERCENT; FOREIGN GOVERNMENTS SUPPORTED 10 PERCENT, AND INDUSTRY'S CONTRIBUTION WAS 7 PERCENT. THE INSTITUTIONS THEMSELVES SUPPORTED 30 PERCENT OF THE STUDENTS.

FOR THE 1000 POSTDOCTORAL STUDENTS, THE FEDERAL SUPPORT PICTURE IS CONSIDERABLY DIFFERENT. FEDERAL RESEARCH GRANTS SUPPORTED 54 PERCENT, WHILE INSTITUTIONAL SUPPORT IN THIS GROUP SHRANK TO ONLY 7 PERCENT, THE SAME FIGURE FOR STATE GOVERNMENTS AND INDUSTRY. FEDERAL FELLOWSHIPS ACCOUNTED FOR 6 PERCENT, AND FOREIGN GOVERNMENTS 12 PERCENT OF THE TOTAL SUPPORT OF THIS POPULATION.

THE GRADUATE PROGRAMS ARE ATTRACTING MANY WOMEN: THEY COMPRISE 30 PERCENT OF THE FULL-TIME GRADUATE STUDENTS, POSTDOCTORALS, AND RESEARCH ASSOCIATES. ABOUT 20 PERCENT OF DOCTORATE DEGREE RECIPIENTS WERE WOMEN.

THE UNITED STATES IS TRAINING SUBSTANTIAL NUMBERS OF FOREIGN STUDENTS. ABOUT 1600 (20 PERCENT) OF THE FULL-TIME GRADUATE STUDENTS AND ABOUT 330 (33 PERCENT) OF THE POSTDOCTORALS HOLD TEMPORARY VISAS. OF THE 1600 FOREIGN GRADUATE STUDENTS, 1200 ARE FROM DEVELOPING COUNTRIES AS ARE 130 OF THE 330 POSTDOCS.

THE LAND GRANT INSTITUTIONS DOMINATE THE GRADUATE PROGRAMS IN PLANT BIOLOGY. THEY ACCOUNT FOR 80 PERCENT OF THE RESEARCH FUNDING, 80 PERCENT OF THE FACULTY, 80 PERCENT OF THE GRADUATE STUDENTS, 80 PERCENT OF THE PH.D. RECIPIENTS, AND 70 PERCENT OF THE POSTDOCTORATE SCHOLARS.

FINALLY, THIS SURVEY REVEALED THAT THE DISCIPLINES OF PLANT MOLECULAR BIOLOGY, BIOCHEMISTRY, AND GENETICS WERE THOSE MOST CITED AS HAVING A SHORTAGE OF PERSONNEL IN POSTDOCTORAL TRAINING POSITIONS, PERMANENT RESEARCH ASSOCIATE POSITIONS AT THE PH.D. LEVEL, AND IN TENURE-TRACK FACULTY POSITIONS. DATA FROM THE SURVEYED INSTITUTIONS ALSO AGREED WITH OTHER DATA COLLECTED BY THE CONGRESSIONAL OFFICE OF TECHNOLOGY ASSESSMENT AND THE NATIONAL RESEARCH COUNCIL: INDUSTRIAL POSITIONS IN PLANT MOLECULAR BIOLOGY, BIOCHEMISTRY, AND GENETICS ARE IN GREATEST DEMAND.

THESE FINDINGS HAVE POLICY IMPLICATIONS FOR INDIVIDUAL AGENCIES AND FOR FEDERAL SPONSORSHIP OF RESEARCH AND TRAINING GENERALLY. AS FOR NSF, I WOULD NOTE THAT THE BUDGETARY GROWTH WHICH I MENTIONED IS A RECENT EVENT. THE DISCOVERIES OF THE 1970'S THAT MAKE UP THE "NEW BIOTECHNOLOGY" WERE POSSIBLE BECAUSE THE UNITED STATES IN THE 1950'S AND 1960'S CHOSE TO BUILD WORLD LEADERSHIP FOR ITSELF IN THE LIFE SCIENCES. FROM 1968 TO 1982, FEDERAL FUNDING FOR NON-DEFENSE RESEARCH IN REAL DOLLARS

SHRANK. THIS ADMINISTRATION REALIZED THAT WE CAN'T LIVE OFF PAST INVESTMENTS SO LONG WITHOUT RENEWING THEM, AND HAS EMPHASIZED PLANT BIOLOGY.

THE HEART OF OUR PROGRAM IS THE SINGLE PRINCIPAL INVESTIGATOR-FUNDED RESEARCH PROJECT. IN FY 1983, GRANTS FROM NSF'S BIOLOGY PROGRAMS AVERAGED $20 THOUSAND PER YEAR IN CONSTANT 1972 DOLLARS. EACH GRANT INCLUDED BOTH TOTAL DIRECT AND INDIRECT COSTS. ONLY IN THE PAST TWO YEARS HAS THE ATTITUDE CHANGED; MODERN BIOLOGY CAN NO LONGER BE VIEWED AS A COTTAGE INDUSTRY. IT IS UNREASONABLE TO THINK THAT U.S. LEADERSHIP CAN BE MAINTAINED WITHOUT INCREASING SUBSTANTIALLY OUR INVESTMENT PER AWARD. I HAVE THE SAME OPINION ABOUT THE USDA'S COMPETITIVE GRANTS PROGRAM.

THE SURVEY BY THE AMERICAN COUNCIL ON EDUCATION INDICATES THAT INDUSTRY'S SUPPORT OF PLANT SCIENCE RESEARCH IN ACADEME IS 10 PERCENT OF THE TOTAL, OR ABOUT $20 MILLION. INDUSTRY SUPPORTS 7 PERCENT OF THE GRADUATE STUDENTS AND ABOUT THE SAME PERCENTAGE OF POSTDOCS. INDUSTRY, AT LEAST PRESENTLY, CLEARLY EXPECTS THE FEDERAL GOVERNMENT TO BE THE CHIEF PATRON OF RESEARCH AND TRAINING. THE DATA CONFIRM WHAT I HAVE HEARD PRIVATELY FROM INDUSTRIAL R&D OFFICIALS. YET INDUSTRY WILL CONTINUE TO BE A MAJOR BENEFICIARY OF THE FEDERAL INVESTMENT. IF LAND GRANT UNIVERSITIES REMAIN DOMINANT IN PLANT SCIENCE GRADUATE PROGRAMS, AND IF THE NEED IN BOTH ACADEME AND INDUSTRY IS CHIEFLY FOR PEOPLE TRAINED IN THE "NEW BIOTECHNOLOGY," IT

SEEMS OBVIOUS TO ME THAT THE FEDERAL FINANCIAL RESPONSIBILITY MUST BE BETTER BALANCED AMONG THE AGENCIES. IN 1984, NSF'S BUDGET OF $33 MILLION, THE USDA'S BUDGET OF $15 MILLION, AND THE DEPARTMENT OF ENERGY'S BUDGET OF $11 MILLION FOR COMPETITIVE RESEARCH GRANTS FOR MODERN MOLECULAR STUDIES OF PLANTS TOTALS $59 MILLION. NSF ACCOUNTS FOR 56 PERCENT OF THIS.

SINCE NSF DOESN'T FOCUS ITS EFFORTS ON AGRICULTURAL RESEARCH, WE REALLY NEED, AS DR. KEYWORTH, THE PRESIDENT'S SCIENCE ADVISOR, HAS SAID, "A SUBSTANTIAL PROGRAM OF COMPLEMENTARY RESEARCH WITHIN USDA." GIVEN THIS, I BELIEVE THAT IN THE FUTURE WE CAN REALIZE WHAT "NEW BIOTECHNOLOGY" PROMISES FOR AGRICULTURE: IMPROVED VETERINARY VACCINES, PLANTS THAT THRIVE IN ARID OR SALTY SOILS, PEST- AND INFECTION-RESISTANT PLANTS, AND CROPS THAT CAN FIX NITROGEN FROM THE AIR.

THANK YOU. I WILL BE PLEASED TO ANSWER YOUR QUESTIONS.

Statement of Dr. Ralph W. F. Hardy
Member of Executive Committee
Board on Agriculture - National Research Council
National Academy of Sciences

INTRODUCTION

Good Afternoon. I am Ralph Hardy, Member of the Executive Committee of the Board on Agriculture of the National Research Council. I am also currently an employee of E. I. du Pont de Nemours & Company where my most recent position was Director of Life Sciences and am also a member of COGENE which is the Committee on Genetic Experimentation of the International Council of Scientific Unions. I appreciate this opportunity to provide comments on U.S. agricultural research and technology. My specific comments will outline the role of the Board on Agriculture, challenges to U.S. agriculture in a changing world, and research and technology to cope with this changing environment.

BOARD ON AGRICULTURE

The Board on Agriculture is one of eight major program units of the National Research Council which is the principal operating agency of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The Board on Agriculture addresses issues in the fields of plant and animal sciences and renewable resources that are of concern to the agricultural community. These concerns range from basic scientific research through its applications in production agriculture to training and education of agricultural scientists, to national policy issues involving natural resources and the nation's ability to produce food, feed and fiber. Areas of interest include all aspects of production, protection, processing and marketing of any crop, plant, or animal and management and conservation of range, soil and water--the renewable resources related to agriculture. The Board is also involved with innovative concepts in agriculture such as biotechnology and its implications for plant and animal agriculture.

Some issues are addressed by the Board to provide advice and guidance on scientific and policy questions at the request of federal agencies or private organizations dealing with agriculture. Other study programs on issues affecting the health of the nation's agriculture and related natural resources are initiated by the Board itself. Projects of the Board on Agriculture are carried out by committees of experts organized for the work of the individual project.

Examples of current projects by the Board include a study for the USDA on bioscience research by the Agricultural Research Service. The resultant report will recommend areas of research that should be strengthened or added to ARS programs in the biosciences to achieve the highest dividends in scientific research. A second project is examining areas in the new biotechnologies that are of significance to agriculture and will recommend a national strategy for biotechnology in agriculture. A third study is evaluating the trends in competency needs in agricultural research personnel. A fourth study will develop strategies for the management of pesticide-resistant pest populations. The above are examples of studies in progress. Several others are in progress or being considered for initiation at this time.

CHALLENGES FOR U.S. AGRICULTURE IN A CHANGING WORLD

U.S. agriculture has, does and will exist in a changing national and international environment. However, the intensity of the rate of change is probably greater at this time than heretofore. This accelerated rate of change will make it increasingly challenging for U.S. agriculture to maintain its competitive position in both its production and input industries.

These changes are occurring in both the domestic and international arenas. I will list some of the domestic factors first. The U.S. consumer expects the desired quantity and variety of food at a low cost. The percentage of income spent for food decreased 16% in the last twenty years and now approaches a new low of 15%. Superimposed on this expectation of low cost food is a growing concern about personal well being and diet. The consumer will increasingly expect food consistent with long-term health. The recent increased visibility of the possible relationship between food and cancer is one example of the growing concern about food and health. Significant changes in diet should be expected with attendant changes in food choices.

The economics of farming is changing drastically with the future of many farmers uncertain. The past emphasis of agriculture research on increasing total yield has greatly enhanced agriculture's ability to produce but not to produce necessarily in a profitable manner. Technologies such as plant breeding including hybrids, artificial insemination, fertilizers, plant protectant chemicals, veterinary pharmaceuticals, feed additives, irrigation, housing and mechanization have provided the bases for high rates of production and low product prices. The increased cost of land and equipment accompanied by high interest rates has led to increased costs. These low prices and increased costs resulted in inadequate profitability. Future agricultural research may need to focus on reducing costs of production in order to maximize return rather than maximize yield.

In recent years, there has been increasing concern expressed about the environment. This includes concerns about possible farm generated pollutants as well as pollutants generated elsewhere that affect agriculture. Some segments of society are expressing hostility towards chemical and biological innovations that have and undoubtedly will be key to keeping our agricultural system competitive. Agriculture must communicate more effectively with society so that society's views are based more on reality than blanket impressions about broad areas such as genetic engineering and plant protectant chemicals.

Agriculture relies on limited resources, such as soil and water. Increasing concern is being expressed about the loss of soil due to agricultural practices. Agriculture is a major user of water and it is suggested that this resource may become limiting in certain parts of the U.S. We must adopt more effective soil conservation practices and improve the efficiency of water use in agriculture or our limited resources will become inadequate or depleted.

Energy is also a changing factor in agriculture. Fertilizer and fuel are the major agricultural consumers up-to-the farm gate of fossil fuels. Although fossil fuel prices have stabilized, in the longer term, prices will again increase driving up the cost of agriculture production. It is noted that agriculture up-to-the-farm gate is not a major national user of fossil energy--only 3% of the U.S. total consumption. Transportation, processing and distribution of food are major users of fossil energy--about 14% of total U.S. energy consumption. The above selected factors indicate the changing domestic environment in which the agricultural production and input industries will have to remain competitive.

There are also significant international factors that impact agriculture especially as the world becomes more interdependent. U.S. agriculture, especially in the case of commodity grains, has the ability to produce huge quantitites in excess of domestic needs. Accordingly, a major part of commodity grains must seek markets outside the U.S. These markets have grown substantially in the 1970's but are subject to year-to-year variations in the productivity of the importing countries such as the U.S.S.R. The U.S. also shares this export market with other grain exporting countries producing additional annual change for the U.S. grain producer. In some cases, importing countries become self-sufficient and even in a few cases become exporting countries in competition with the U.S. Some countries that are importers of agricultural products will invest to become self-sufficient in the future. The ability of the U.S. to export agricultrual products can be affected drastically by political considerations. These changes in the international market produce the major impact on grain prices and document the increasing world interdependence in the changing agricultural environment.

In addition, agriculture is subjected to the changing impacts of evolving technologies whose impacts could be even more dramatic than the international marketplace. For example, the new biology-based technologies are expected to have major impacts on both agricultural production and agricultural input industries. In the shorter term, it is absolutely critical that the U.S. develop a leadership position in these biotechnologies for both our agricultural production and input industries. These biotechnology inputs should enable production costs per unit of product to be decreased and should provide the bases for competitive new products, processes and services for our ag input industries.

For the longer term, we need to assess the impacts of the biotechnology inputs on U.S. production agriculture. The nature of some of the expected products of these technologies such as seeds are ones that are easily introduced. Note the successful introduction of high yield wheat varieties into

India so as to convert India from a wheat importer to exporter. One may suggest that these biotechnologies in the long term will decrease the competitive advantage of U.S. production agriculture. For example, technologies that would enable high yield crops to be grown on the aluminum toxic soils in South America would lead to major increases in crop production of that part of the world while the impacts of such technology on U.S. agriculture would be less significant. Similarly, vaccines to decrease animal diseases in areas such as Africa could substantially increase the meat producing capabilities of that continent. Evolving technologies can clearly produce advantages but also can produce challenges for which we need to prepare. Developing the appropriate technology is the best answer to such challenges. Thus, technology must be considered as a major opportunity and challenge in a changing world. One must develop the best technology for U.S. agriculture but recognize that others are pursuing the same goals for their agriculture.

In the changing world, it may be most important to develop technology that would generate new markets for production agriculture. Research is needed to provide the basis for making higher value-in-use products than commodity grains. Such technology could significantly increase the competitive position of U.S. production agriculture.

The many national and international changes outlined above suggest that maintaining the competitive position of U.S. agriculture will not be easy. It will require an aggressive approach over the next several decades to maintain or even more desirably enhance the competitive position of U.S. agriculture. In the next section, I will suggest some approaches that will assist in meeting this challenging objective.

RESEARCH TO COPE WITH A CHANGING ENVIRONMENT

The key ingredient to cope successfully with this changing environment is people. Agriculture must attract the most creative minds to design solutions for these most challenging problems. In recent decades, agriculture has not attracted its fair share of the best talent compared with fields such as health and engineering. Programs such as the recently initiated National Science Foundation Post-doctoral Fellowships for students educated outside of agriculture to do post-doctoral work in agricultural laboratories is an innovative effort to readjust the people distribution in favor of agriculture. Agriculture also has a responsibility to inform young people at the critical time of career choices as to the exciting challenges and opportunities in agriculture. Success in attracting these creative minds will be important to our academic, government and industrial agricultural activities as well as providing talent key to maintaining our international leadership position in agriculture.

After people, the next most important factor is training. We must expand our capabilities to train young scientists and to retrain established scientists in the newer biological techniques. Academic and government laboratories have the major responsibility for training. The expanding agricultural biotechnology emphasis of many academic institutions is encouraging. However, these programs will need to be staffed by agricultural biotechnologists of which there are only an inadequate number at this time. Training is key to provide the future scientists for academic, government and industrial activities as well as international ones.

The next important factor for agricultural research is funding. To provide options to meet the competitive challenges of the changing world will require new research initiatives especially in providing a strong base of science to underpin agricultural technologies. The health care community has shown competitive grants to be a most effective way to fund creative science. The strong existing scientific base in the medical sciences documents the effectiveness of competitive grants. Agriculture initiated a modest competitive grant program a few years ago. We are encouraged by the expanded competitive grants for a biotechnology thrust this year. We recommend substantial additional expansion of competitive grants over the next several years. In addition, we suggest that the competitive grants in agriculture be of two types. One would be the traditional single investigator, monodiscipline proposals. The other would be multiinvestigator, multi-discipline proposals. Available competitive grant funds would be allocated in advance between the two types. Let me justify the reasons for the multiinvestigator, multidiscipline proposals. Many of the research problems in agriculture will require a multiplicity of disciplines to successfully generate the science and technologies. Multiinvestigator, multidiscipline proposals will bring together creative scientists to meet this need. The limited number of recently funded interdisciplinary grants by the McKnight Foundation is an example of the above. Furthermore, students trained under such multidiscipline, multiinvestigator research endeavors would be expected to be more multidisciplinary in their outlook and comfortable in working in a variety of disciplines as is often required in the more applied sides of public sector and industrial agriculture.

These competitive grants which will provide the new science and technology base for competitive agriculture production and input industries should not be funded at the expense of more applied programs that are judged to be critical to current agricultural problems. I also wish to comment on industrial support of university R&D. Although there has been some increase in this activity in recent years, I would not expect any more than a minor part of this basic R&D funding long term to come directly from industry.

Another key ingredient for competitiveness is the appropriateness of facilities and the equipment for the research to be done. Agriculture not unlike many of the other research areas in the U.S. needs equipment and facilities that will facilitate rather than impede scientific progress. Instrumentation for the new technologies are significantly different than those for established technologies.

The opportunity for new science and technology relevant to agriculture is outstanding at this time. The opportunity is not unique to the U.S. and agricultural activities in the U.K. and Australia, for example, are highly competitive if not more advanced than U.S. activities. For example, I recently had the opportunity to be part of an overview committee for the plant sciences part of an Australian Commonwealth Scientific and Industrial Research Organization. Their integration of these newer techniques into plant sciences was impressive. We must therefore move aggressively in developing these new sciences and technologies if we are to maintain a competitive edge for U.S. agriculture and agriculture input industries. These new technologies are those referred to as genetic engineering and monoclonal antibodies and tissue culture and undoubtedly there will be more as our base of exploratory biological sciences expands. Several reports such as the 1982 COSEPUP Report on Plant Sciences identify priority opportunities.

The science base in agriculture for the new technologies is relatively weak throughout the world. These technologies rely on the identification of key genes or enzymes in crop and animal agriculture. Our understanding of the physiology and biochemistry of key molecules in both plant and animal agriculture, is very limited at this stage. Thus, we need to substantially expand these fundamental sciences to identify those molecular targets that it will be most useful to manipulate in crop plants and domesticated animals.

We need also to understand regulation of gene expression in plant and animal cells. Such knowledge will be key in developing molecules to turn off or turn on genes at desired times. This ability to regulate genes may be the key to the agrichemical input industry of the future.

These new technologies are expected to provide products, processes or services for many needs of animal and plant agriculture. They will have potential for the U.S. but also for other developed countries, less developed countries, and centrally planned economies. These products are expected to decrease the cost of production, increase yield, reduce vulnerability to stress and pests, stabilize yield, reduce risks, and expand the useful world cropping land.

Model gene transfers have already been accomplished in experimental plants and animals and one expects that within the next year or so, transfers of simple agronomic traits in plants and possibly useful characteristics in domestic animals will be accomplished. However, it must be recognized that the new technologies are relatively untested. Their utility remains to be demonstrated in the marketplace.

The above expanded thrust in agricultural research will require effective technology transfer in order to achieve the desired competitive position for U.S. production agriculture and agriculture input industries. Various experiments are being tried on relationships between the academic community and the private industrial sector. Presumably out of these experiments will come more effective ways to transfer technology from the public sector--universities and government--to the private sector. Also, an Academy organized roundtable of government, university and industry representatives is discussing the relationship of the three sectors.

In an expanded thrust in ag research, there must be a requirement to monitor and evaluate scientists and programs. This will probably require an expanded effort of program evaluation where public funding is involved but conducted so as to facilitate the most rapid progress in the areas that will maintain or increase our competitive advantage. Monitoring must be more sophisticated than simply quantitation such as publication counting but must emphasize quality.

The above suggestions indicate areas and factors that we must emphasize if we are to provide the science and technology base to maintain the competitive position of U.S. agriculture in a changing internal and external environment. There are other policy factors which are important for maintaining or enhancing U.S. competitiveness in agriculture but which are not the focus of my statements today. One is the strength and duration of proprietariness that is key to the competitiveness of agricultural input industries. Many of the products of this area including the new biotechnologies will require a demonstration of safety and efficacy. Such a demonstration will probably take considerable time. For industry to contribute maximally in the agricultural research area, patent term restoration legislation would be a key ingredient.

Let me summarize. U.S. agricultural production and input industries will need to compete in a more rapidly changing world environment. Many factors support this accelerated rate of change. Several factors--people, training, funding, facilities, programs, technology transfer, and accountability--are identified as key to providing a strong base of science and technology to maintain or hopefully increase the competitive position of our U.S. agricultural industries.

Testimony before the U. S. House of Representatives Committee on Agriculture, Subcommittee on Departmental Operations, Research and Foreign Agriculture

June 6, 1984[1]
by
Richard S. Caldecott[2]

Mr. Chairman and members of the committee, when you requested that a representative of the McKnight Foundation provide testimony, the Executive Vice President, Mr. Russell V. Ewald, asked me to undertake the assignment because he had a prior commitment. I accepted with enthusiasm because it provided an opportunity to address the significance of the unique and bold initiative taken by the McKnight Foundation and the importance of that initiative being emulated by Federal and other agencies which support university-based research and training.

Before providing the rationale behind the establishment of the McKnight Foundation program let me diverge to address the issues of the "Draft Charter" on which commentary was requested; the remarks are relevant to the testimony that will follow.

One can never emphasize too strongly that the great success of scientists in the United States following World War II was made possible by funds provided by the Federal Government to major research universities. The support was given primarily through peer determined awards for research and training that were made to "individual" scientists for studies that were disciplinary in nature. With the exception of the USDA, which was not a significant party to the process, the infrastructure that has been developed is unmatched anywhere in the world. However, to stand pat with what is in place would be a mistake of the first order, particularly as it relates to agriculture. Let me make a few assertions for the record which may serve as points of focus both for discussion from the floor and in future deliberations of the committee. First, the integrity of the peer review process must be protected and expanded with respect to general support for the scientific community and specific support in areas relating to agriculture. Second, a rigorous process must be developed for encouraging and reviewing proposals from groups of scientists who wish to use a team approach in solving problems and in training students. In that respect, the approach used by the McKnight Foundation might serve as a model. Third, a method must be found to assure that the rewards from research conducted in the laboratories of United States scientists result in new employment opportunities and appear on the balance sheets of U.S. corporations rather than on those of our international competitors. Fourth, steps must be taken to guarantee that both the scientific infrastructure and the financial support provided for research and training will be maintained at a level that assures that the national security and the health and welfare of the citizenry never will be compromised. In this regard, such a compromise certainly will occur if the major state supported research universities that expect enrollment declines through 1995 continue to be funded using a formula that relates financing from the state to the number of "undergraduate" students in the classroom. It is important for you to recognize that many of the young scientists who are being trained today are having difficulty in finding suitable positions in major research universities. The reason is that in recent years many of these universities have suffered from retrenchment of state funding. To exacerbate the situation many universities are not planning to fill those faculty vacancies which do occur because they are anticipating a further reduction in student enrollments during the next decade with the consequent further reduction in state support. What is seldom taken into account by state legislatures is that most faculty members are devoting a major portion of their energies to graduate education and research, the need for which will go unabated and without which state and national economies will suffer. If the trend continues it will result in a "lost" generation of scientists at a time when international competition becomes ever more reliant on "information" that is derived from scientific enquiries.

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[1] These remarks should be considered as expressing the personal opinion of the witness.

[2] Professor of Genetics, University of Minnesota and Consultant to the McKnight Foundation for Programs in Plant Biology.

The obvious way to overcome this problem is for the states and the federal government to recognize that the future is dictated by the past. There prevails an overriding national need to formalize the unofficial partnership that exists between these governmental bodies by devising new funding patterns for supporting and training scientific personnel.

When the McKnight Foundation decided to undertake a program of forward-looking support of research in the plant sciences, they had one principal objective: to finance "state-of-the-art" research that could be expected to have a positive impact on agricultural production in the year 2000 and beyond. To determine a strategy that seemed most likely to help the Foundation achieve this goal, a series of meetings were held with the program chairman, scientists in several universities, representatives of three government agencies, and the management of the Foundation. The result of these deliberations was the preparation of a proposal for the Foundation Board that emphasized ten areas urgently requiring funding. They are as follows:

1. The establishment of cell and tissue culture techniques which can be used in whole organism regeneration.
2. The molecular basis for the control of gene expression and the _in vitro_ modification of isolated genetic material.
3. The regulation of gene expression during growth and development.
4. The isolation and transfer of blocks of genes, whole chromosomes, and organelles within and between species.
5. The segregation and breeding behavior of genes in the material into which they have been introduced.
6. The molecular basis of the response of plants to infection by fungi, viruses, bacteria, and insects, and the impact of the environment on that response.
7. The molecular basis of the action of plant growth regulators.
8. The biological control of the growth and dispersal of plant species which impair agricultural productivity.
9. The relation of plant growth and development to environmental factors such as light, temperature,

moisture, and nutrients. These investigations would also examine such stress factors as salinity, drought, mineral deficiencies, etc.

10. Plant productivity as limited by photosynthesis including: the interaction of the nuclear genome and the chloroplast genome, the role of photosynthetic herbicides, and the production of herbicide resistant genotypes.

Solutions to the various problems indentified as important require varying degrees of integration and coordination of the research interests of individuals from divergent backgrounds. Thus, the program was designed to be broad enough in scope to provide funding of two sorts. First, for promising young scientists who were working in relatively well-defined areas and who could use a three year period for concentrated study, and second, for groups of individuals who were working in an interdisciplinary mode to accomplish objectives which can only be achieved by pooling diverse talents.

It was evident to the McKnight Foundation that funding could not be provided for all the research that is worthy. However, it was felt that they could play an extremely important role in several critical areas which might provide a stimulus for support by other agencies. Thus, it was decided that projects to be supported would be of such high quality that their selection would attract the attention of all those agencies who have as their prime responsibility the financing of plant research.

It was further decided that the programs to be financed must earmark major fractions of the funding provided for supporting graduate students and postdoctoral personnel. This was done to emphasize the need for immediately beginning to prepare those who will provide the scientific expertise in the year 2000 and beyond.

It was agreed that the level of funding for individual awards would be a non-renewable commitment of $35,000 per year for three years; ten such awards have been made. The initial funding for the interdisciplinary awards ranged from $200,000 to $300,000 per year for three years; six awards have been made. The McKnight Foundation reserves the option of renewing the interdisciplinary awards for additional periods if warranted by the progress made during the first grant period. The program is expected to continue for a ten year period at a funding level of about $1,850,000 per year.

A unique feature that the McKnight Foundation Board approved when the program was established was a review process that would bring to one location, on an intermittent basis, all the participants in the program including in particular those who were being trained. The first review, which will be conducted in the late spring of 1985, will involve presentations by each of the trainees so that an inter-institutional comparison can be made of the effectiveness of the different programs in meeting their specified training and research objectives. Following the presentations, the entire group will be asked to comment on the strengths and weaknesses they observed in the program and what new areas of research should be supported.

The McKnight Foundation was aware that on several occasions other agencies had initiated programs of interdisciplinary research only to find that the proposals submitted to them were wanting in terms of scientific rigor and, concomitant quality. There are several reasons for this deficiency. The overriding one seems to be that funding of scientists by the granting agencies usually emphasizes the individual and what he/she can contribute scientifically as an independent investigator. Typically, universities reinforce this bias by basing their tenure decisions on the merits of the individual as perceived, for the most part, by his/her independent contribution whether it be in research, teaching, or service. A system driven in this way assures that the best in the scientific community usually will conduct their careers by concentrating their efforts in restricted areas of endeavor. It is without doubt that this approach will continue to result in discoveries of major significance in areas such as molecular biology and, therefore, must be aggressively continued. However, it must not be forgotten that this procedure is based largely on a "reductionist" approach to problem solving which tends to ignore the fact that in living systems the rule is for the product to exceed the sum of the parts of which it is comprised.

Success in interdisciplinary research demands a scheme which brings the best of the reductionists and holists together in an environment where they are encouraged to look at higher order associations and the functioning of systems at a level which their individual techniques will not resolve. That is the goal of the McKnight Foundation program in Interdisciplinary Plant Biology. There is no doubt in the minds of those who formulated the program that it is the wave of the future, particularly in the applied areas of the life sciences such as agriculture and medicine.

The challenge before the granting agencies and universities is to structure opportunities, both for fiscal support and personal advancement, in such a way that the best among our scientists will not shy away from interdisciplinary research because of the fear that it will have a negative impact on their professional careers and fiscal rewards.

The team selected to advise the McKnight Foundation was mindful of these considerations. They were chosen for their expertise as scientists and administrators and their willingness to devote long hours to reviewing proposals that they hoped would be at the cutting edge of the future and set an example both for the scientific community and those to whom they look for support.

In total, 148 requests were made of the McKnight Foundation for individual support and 89 for interdisciplinary research and training. Ten grants were provided to individuals and six to interdisciplinary teams. The quality of the proposals received was mixed. Some investigators who sought support for interdisciplinary research had not thoroughly worked out their research protocols and how the graduate student training would be accomplished. These requests had the appearance of a collection of individual research projects that as a whole lacked coherence. There is little doubt, however, that if funds had been available, simply on the basis of quality alone, awards could have been made to at least ten other interdisciplinary groups of scholars.

It has been ascertained from informal conversations with colleagues, that the approach taken by the McKnight Foundation has proven to be an important catalyst in stimulating a great deal of discussion relative to how universities can structure their faculties and research efforts in a way to encourage much more interdisciplinary research. These discussions have been augmented by the burgeoning interest in biotechnology and the efforts that universities are making to develop new kinds of associations between their faculties and the industrial community. There is no doubt that these occurrences in universities augur well for the future. Correspondingly, it will be more difficult and challenging for the McKnight Foundation in examining the second round of proposals which will be forthcoming in twelve to eighteen months. I shall be pleased to report to you on what is observed.

Testimony of Dr. Sue A. Tolin

Professor of Plant Pathology

Virginia Polytechnic Institute and State University

Before The

U. S. House of Representatives

Subcommittee on Operations, Research and Foreign Agriculture

of the

Committee on Agriculture

Agricultural Research, Extension and Higher Education Hearings

June 6, 1984

Good afternoon. I am Dr. Sue Tolin, Professor of Plant Pathology at Virginia Polytechnic Institute and State University, where I teach virology and conduct research on viruses that cause diseases of our major crops. I work with plant breeders and geneticists to develop crop cultivars resistant to certain viruses and conduct research to understand the molecular and genetic basis of plant resistance and viral pathogenesis. I currently also hold a part-time IPA appointment with USDA, Cooperative States Research Service (CSRS). Since 1979, I have served as the U. S. Department of Agriculture's representative to the NIH Recombinant DNA Advisory Committee (RAC). I am also a member of the USDA Recombinant DNA Committee representing CSRS.

I thank you for the opportunity to appear at this hearing and to discuss the type of regulatory approval process for release of new organisms I believe would insure protection of the environment without destroying the potential of biotechnology in agriculture. I will emphasize in my remarks those new organisms in which recombinant DNA technology has been utilized in their development, recognizing that biotechnology encompasses a much broader area.

It is widely acknowledged that U. S. agriculture is based on the cultivation of many introduced species of plants and animals. Traditional breeding and selection techniques have been utilized by agricultural researchers to introduce and improve these species for increased production efficiency. The genetic basis for important traits is known in many cases, and genes have been manipulated by breeders by many different approaches. With the recent developments in molecular biology and biotechnology, new opportunities are becoming available for increasing our understanding of the structure and function of specific genes in plants and animals, and particularly in the viruses and microorganisms associated with them. There are now many examples in which specific genes associated with pathogenicity or with response to a biological or physical stress imposed on a plant have been isolated and cloned into another host by recombinant DNA techniques. Molecular vectors have been developed and used to manipulate the genes in microorganisms or higher organisms which then must be tested first under controlled conditions and then under natural field conditions. The testing and later commercialization of these modified organisms has raised [illegible] enormous number of questions concerning their regulation.

Regulation of organisms modified by recombinant DNA techniques currently require approval by the NIH Recombinant DNA Advisory Committee (RAC), in accordance with the "Guidelines for Research Involving Recombinant DNA Molecules". The National Institutes of Health promulgates the Guidelines, but other federal agencies have been enjoined to comply with them for their research and other activities under their authority. Non-federally funded organizations excercise voluntary compliance. The RAC has utilized the expertise of scientists from several disciplines and from other federal agencies in making recommendations to change the guidelines as additional scientific information has become available. Specific requests for permission have been granted to conduct experiments requiring approval. In the early days of the guidelines, most experiments required review and approval. After review of a number of similar requests and establishment of certain scientific principles, the RAC acted by developing a "generic" statement for a class of experiments which then could be reviewed and approved by the Institutional Biosafety Committee (IBC) at each local institution conducting the research.

Approvals for the release of organisms containing recombinant DNA have been recommended by the RAC when it was judged that the alteration of the genome was of minimal significance to the organism and would in no way be analogous to introducing an entirely new organism. In future reviews, I believe that initial review of the engineered organism should be either by the RAC or by procedures that they develop, with either simultaneous, pre-, or post-review by the appropriate agency with regulatory authority for the organism in question. In this way, the proper expertise would be utilized for the molecular nature of the gene sequence(s) altered (the RAC) and for the characteristics of the organism (federal or state agencies). Not all of the regulatory processes would be alike. As currently done in agriculture, protocols have been established for release of organisms for commercial agriculture which are based on long experience and observations.

Testimony

of the

American Institute of Biological Sciences

Presented to

The Subcommittee on

Department Operations, Research and Foreign Agriculture

of the

Agriculture Committee

of the

U.S. House of Representatives

on

June 6, 1984

Presented by Charles M. Chambers, Ph.D., J.D., to the House Subcommittee on Department Operations, Research and Foreign Agriculture, June 6, 1984.

MR. CHAIRMAN AND DISTINGUISHED MEMBERS OF THE COMMITTEE:

My name is Charles Chambers. I am Executive Director of the American Institute of Biological Sciences. I am joined by Dr. Robert F. Acker, the AIBS representative of the Society for Industrial Microbiology. Dr. Acker is also Executive Director of the National Foundation for Infectious Diseases and former Executive Director of the American Society for Microbiology. AIBS is a national confederation of over forty professional societies and research organizations in the life sciences. Together our groups represent some 70,000 working biologists in the biological, agricultural, environmental and medical sciences.

It is my great pleasure to appear before you today to present our views on biotechnology in agriculture and more specifically, to address the biotechnology proposals of the Department of Agriculture.

It is important that we move ahead rapidly and soundly in this field, which has such particular importance for the development of agriculture.

Although the word "biotechnology" has only recently appeared in the public policy lexicon, the use of whole organisms or their components in industrial processes is not new. Fermentation is one of the most familiar examples. Genetic engineering as applied to microorganisms has led recently to such breakthroughs as bacterial production of interferon, and a noninfectious vaccine for Hoof and Mouth Disease. Despite these and similar success stories, we have only begun to tinker with a handful of the properties of organisms in this way, and their collective potential is limitless, for all practical purposes.

Although it may seem far removed from biotechnology, the protection of natural resources and endangered species, including some humble insects and microbes, is scientifically important. Every organism, regardless how incidental it may appear, that becomes extinct reduces the available genetic material on which biotechnology can operate, i.e. recombine. This genetic material is important to us because it will be a long time before we can synthesize functioning genetic structures in the laboratory. For this reason alone, we are well advised to preserve as much natural biological diversity as possible in the form of gene parks, natural habitat, mixed forests and other ecosystems and to make renewed efforts to survey and catalog existing plant and animal species. AIBS and many other scientific organizations support the concept of biological inventory, both in the United States and abroad.

Next, agricultural research scientists have long been able to improve and adapt organisms ranging from microbes to plants and animals. In fact, a great deal of the phenomenal success of American agriculture can be traced directly to the application of genetic concepts and principles. Today, biotechnology gives us new and more effective techniques for achieving the identification, characterization, replication, regulation and functional transfer of genes based in part on techniques such as embryo transfer, cell culture, regeneration of whole plants from tissue culture, and somatic hybridization. It holds great promise for the improvement of food supplies for a hungry world.

Our country has developed a preeminent peer-review system for judging scientific merit, and the Federal government in particular has been especially farsighted in adapting this system into its regulatory practices in food, drug, health, environment and other areas of public safety and protection. These are sound practices that can easily be enhanced and adjusted to facilitate the development of one of the greatest potential tools for improving and protecting not only human health and the environment, but also the economic productivity of our fiber industries and other renewable resources. As Judge Sirica recently reminded us (Foundation on Economic Trends v. Heckler, No. 83-(2714)(D.D.C. Sept. 14, 1983), injunction granted May 16, 1984), however, rules carefully adopted to balance the interests of science and society, i.e., environmental impact statements, should not be lightly abandoned. Let me briefly review key aspects of genetic engineering relevant to your charter and conclude with some specific recommendations for improving the Federal government's monitoring and oversight practices.

To appreciate the risks involved in experimenting with genetically engineered organisms, we need to review the status of plant and animal species in agricultural production. Through years of selection, hybridization and breeding, food and fiber organisms have been developed with such features as improved yield, nutrition, and palatability, but at some cost. Such desirable characteristics often are not compatible with survival in the world, and only through man-directed cultivation, fertilization and pest protection are most crops and domestic animals able to grow and prosper. They have very little ability remaining to survive on their own, and the adjustments we can make biotechnologically to them pose minimal risks of their reinvading the world. Indeed, there are other risks involved in refining desirable genetic properties to too high a degree through laboratory recombination and synthesis. The adaptability of the organism to the environment, i.e., its fitness, is frequently reduced, and it may not only be difficult to cultivate at acceptable levels of production but also be susceptible to new strains of pathogens, which are naturally present. The breeder must then try to adapt another polygenetic system to incorporate the needed resistance and then face vigorous and lengthy testing to establish its basic productivity. Similar problems exist in the area of animal health and productivity.

For these reason, the genetic manipulation of domestic plants and animals does not appear to be a matter for great environmental concern. However, because organisms can self-reproduce, a qualitatively different level of scientific review and monitoring is required. First, wide consultation for release of all such organisms is highly desirable. Next, the further development of the field of microbial ecology would appear to be of great importance for the proper appreciation of apparent risks. Finally, under existing legislation and administrative practice, Federal research agencies have authority to approve the release of organisms into the environment, including those that have been genetically designed using biotechnology techniques. In the latter case, specific oversight is exercised by the NIH Recombinant DNA Advisory Committee (RAC).

As more research proposals are made involving the field testing and commercial production of such organisms, reliance on the advisory review process, which has the necessary administrative expertise, should continue. Further, committees like RAC and USDA's Recombinant DNA Research Committee (ARRC) should expand their membership to include professional environmental and agricultural scientists.

The efforts being made by EPA to monitor and apply a constructive role in this field should likewise be encouraged, and those federal agencies involved in the process should coordinate their efforts and develop uniform guidelines and procedures.

By undergirding the government's regulatory process at the federal, state and local levels with the strength of scientific peer review, we can maintain the initiatives in basic plant genetic research supported by the National Science Foundation and the indispensable applied research in agriculture and other health related areas supported by other agencies. Only through a vigorous program of competitive grants and support for modern instrumentation at both the basic and applied levels can our nation maintain its agricultural leadership and scientific excellence. The commendable professional relations which exist between NSF and USDA should be encouraged, strenghtened and perhaps even formalized and extended to the entire agricultural community via jointly funded projects, fellowship exchanges, pooled laboratory resources, etc. While we must continue to maintain a broad based network of research institutions and field stations to implement future scientific findings, innovation and momentum can only be assured if research proposals are sought from all qualified institutions and awards are made on the basis of merit and potential utility.

This Institute firmly believes that we are on the threshold of a golden era in agriculture and biologically driven industrial processes. For those reasons we are developing a national Food and Agriculture Policy Forum to insure that the highest quality of scientific expertise continues to inform and assist the public policymaking process in all its political, social and economic dimensions. We commend the

Subcommittee for its willingness to devote its valuable time and attention to this area. We support an expanded competitive grants program and renewal of equipment and instrumentation, and urge the development of proper guidelines for assessing the possible environmental impacts of experimentation in this area as rapidly as possible, so that our nation's progress in this important field will not be impeded. We thank you for the opportunity to present our views, and would be please to respond to any questions you may have.

NEEDS ASSESSMENT--IMPLICATIONS OF THE NEEDS ASSESSMENT FOR PRIORITY-SETTING, PESTICIDE USE, AND TECHNOLOGY AND FARM STRUCTURE

THURSDAY, JUNE 7, 1984

House of Representatives,
Subcommittee on Department Operations,
Research, and Foreign Agriculture,
Committee on Agriculture,
Washington, DC.

The subcommittee met, pursuant to call at 9:55 a.m., in room 1302, Longworth House Office Building, Hon. George E. Brown, Jr. (chairman of the subcommittee) presiding.

Present: Representatives Penny, Volkmer, Roberts, Gunderson and Evans of Iowa.

Staff present: Cristobal P. Aldrete, special counsel; Peggy L. Pecore, clerk; William A. Stiles, Jr., Bernard Brenner, Anita R. Brown, and Gerald R. Jorgensen.

OPENING STATEMENT OF HON. GEORGE E. BROWN, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. Brown. The subcommittee will come to order. We are trying to get additional members to be here, but we may have some difficulty due to the number of other activities that are going on.

I have a short opening statement which I would like to read at this time. Today, we are beginning the second day of this set of hearings. The major topic before us is to understand the implications of findings in the Joint Council's recently completed study "Needs Assessment for the Food and Agricultural Sciences." This study was required in the 1981 Farm Bill as part of a three-step process of long-range planning and priority-setting for the very complex, decentralized agricultural research, extension and teaching system.

The needs assessment serves as a foundation for long range planning by presenting a broad consensus on the major needs and opportunities facing the food and agricultural system in the coming decades. It is a very comprehensive document that covers every area of agricultural science and touches on many current controversial issues.

For example, there is a recognition that mechanization research may no longer offer a significant return on investment due to the very small labor component remaining in agriculture. There is concern expressed in the report about the trend toward larger and fewer farms and a research agenda is suggested to understand the implications of this phenomenon. This is not a new concern since we have been studying the problem for quite a few years. There is a recognition that growth in demand for U.S. production will be slow over the next two decades, which implies that reducing production costs should begin receiving greater emphasis than simply increasing yields. There is a major emphasis on multi-disciplinary, integrated systems approaches, which currently face significant obstacles at many public institutions.

Reading the last two sentences, I am struck by the fact this situation is not one unique to agriculture, but to the whole of our economy and one in which we should be trying to apply lessons that we learned in one sector to the problems that exist in other sectors. Agriculture has a great deal to teach and maybe a little bit to learn from the way the problem is being handled in other parts of the economy.

We must insure that this excellent study is used. The study can be used as a comprehensive justification to policy officials for increased real funding of the food and agricultural sciences. But this case will be strengthened if it is also used as a menu from which to select the most urgent priorities at this time of fiscal constraint. Consequently, we will be assessing the Joint Council's Five-Year Plan, which I have just received a published copy of this morning and which impresses me a great deal, and the annual priorities and accomplishments reports to see if these are resulting in a useful long-range planning process for the system.

We embarked on this effort in the 1981 farm bill without a preconceived notion of what the end products should contain. Today's witnesses will help us understand whether the statutory process is useful or burdensome. The critical question is whether or not it is having an impact on the system.

We will be guided by the results of this hearing and subsequent analysis in the process of redoing the farm bill next year and correcting any problems that may have developed. Today we will hear from a variety of nonfederal witnesses. On June 13, USDA policy officials will offer their perspective on the long-range planning process and other issues raised during the hearings.

I would yield to my good friend and ranking member of the subcommittee, Mr. Roberts, for any comments he may have.

Mr. Roberts. I have no comments, Mr. Chairman.

Mr. Brown. In case you think of any, they will go into the record at this point.

Our first witness is Dr. Roald Lund, who is representing the Joint Council on Needs Assessments issues.

STATEMENT OF H. ROALD LUND, DEAN AND DIRECTOR, COLLEGE OF AGRICULTURE, NORTH DAKOTA STATE UNIVERSITY, REPRESENTING THE JOINT COUNCIL

Mr. Lund. Since there is nobody behind me, I will stand to one side.

Mr. **Brown**. You may proceed in whatever way you see fit. If you summarize, your full statement, as is customary, will appear in the record. So you need not worry if you don't read it completely.

Mr. **Lund**. Thank you, Mr. Chairman and members of the committee and the audience assembled. Basically my presence here, is more important than what I am going to say and even maybe the written document—it is really important to those of us in the States. I am a dean of a college of agriculture, the total university has about 9,500 students, with about 1,300 students in the college of agriculture and about 300 students at the graduate level.

Also I am director of the experiment station in the State of North Dakota. North Dakota is a State found in the center of the Nation, the Great American Desert they used to call it. We have land. We have a lot of land, much like the other persons that are going to speak and the persons you represent.

One time, all we had in this country was land. Of course, if you travel in the European countries you will discover the ministry of agriculture is one thing and education of the young men and women is another. In this country, as dean of a college, I can sit on a graduating platform, like I did last weekend, watching about 1,700 young men and women with degrees in agriculture, engineering, pharmacy, home economics and the other sciences walk across that stage and become a part of society in roles they would never have a chance to fill, if they were in any other country but the United States.

The land grant concept that came into being right here in Washington, when Abraham Lincoln could have stood in his office window and looked at the smoke of the battles when brothers killed brothers, where did the roots of this thing come from and what has it turned out to be? It has actually become much more than anybody ever thought it would be. The giving away of the Federal land—can you imagine today, what the Washington Post would say about giving away the Federal land?

So the point is, I guess that we need to continue to think about this grass roots effort. Where have we come from and what are we going to do and what are we going to represent in the future?

So my statement as I look back on a short career in administration, I can look forward to a longer career in planning. When I came into administration, the word, "CRIS," was brand new, so was the National Agricultural Library. There was a brand new IBM 370 computer in the building. People were excited about the use of the computer to maintain an inventory, the current research information system, they called it.

So as a young budding administrator, I began to work with the CRIS system. We worked with that. We found that we had the best inventory of any in the Nation, and possibly the world, about agricultural research. This system is jointly supported by the State agricultural experiment stations and the Agriculture Research Service with many, many, many member agencies.

What has happened over the past nearly 20 years is that CRIS has become more and more important as a planning document, a planning instrument, than it originally was, when it was simply a research inventory system. And so as the years have gone on, we have found more and more data accumulated.

What do we do with it? There have been fits and starts on planning. There is an interregional committee, the IR-5 CRIS Operations Planning Committee. I serve as the chief administrative advisor to that. I have always felt that planning was an important part of record-keeping. It hasn't been until recent years with the coming of the joint council, which really made the parts fall together.

Here we have about 50 rugged individualists out in the States leading the research programs. The bulk of the agricultural research that is done in this Nation is done in the individual agricultural experiment stations and I stand as a director of one of those stations.

Why should I listen to Washington, DC? Eighteen percent of my budget comes from the Federal Government, down from 26 percent 10 years ago, and 30 percent 20 years ago. So the voice of Washington gets to be less and less as far as I am concerned as a State agricultural experiment station director, trying to respond to the needs of the people of my State.

But here we have the chance in the joint council and users advisory board to have a forum. All of the partners then, the Agricultural Research Service, Economic Research Service, the Forest Service and the separate and independent State agricultural experiment stations, have a chance to form, to meet together, to talk. That is what is important today.

You have before you a 5-year plan. If you were to look into the Agricultural Research Service, you would find a 6-year plan. If you were to look into the extension service, you would see an extension in the 80's plan. Every group is ready to sit down and plan, but where is the forum? The forum is the joint council.

For the first time in 200 years this country has been trying to maintain an agricultural enterprise. We now see a forum. So you see the burgundy colored book. You have seen a green colored book. You have seen a brown 1983 accomplishments and soon 1984 accomplishments report. You have seen the summary, of the needs assessment.

This logo on the cover of each joint council report, I hope, is one that your committee and members of the Congress and other personnel begin to remember the big A. The big A is made up of three component parts: research, teaching, and extension. That is what that stands for. I think the sooner we can continue to remember that this is part of our business, and part of our heritage, the better off we are all going to be.

One other thing we have a group of men and women that are interested in what is going on at the grass roots level. This is the users advisory board. I want to speak to that, the new user' voice for science and education in agriculture. Again, there is a group of young men and women who are saying what is going on in agriculture. We want to know. So their report also is important.

The different groups that make up our agricultural experiment stations are quite interesting and diverse—there will be more comments on that. The advantage of being the first person on a program like this is you can lay out maybe the prelude, the opening strains of the chorus, you might say.

I hope that the following testimony of the witnesses this morning will continue to harp on some of the things that are important in these many reports. But in the front page of this report "Research 1984, the State Agricultural Experiment Stations," and you are going to see this report again and again, it shows the many partners, the public and the private sector of a $3 billion agricultural research enterprise.

Where is the forum? The forum again is the joint council. We don't always have to depend on ourselves to talk about agriculture. There is the Winrock report, not the infamous Winrock report which has been commonly misunderstood. The Winrock report was really a positive statement about the diversity of agriculture, the strength of the diversity of agriculture. This Winrock report gives views on world agriculture and prospects into the 1990's.

There is one paragraph at the back of that report that is really important. It gives the implications for the United States. What does agriculture really mean? There is a statement there that in essentially every respect the United States is one of the world's few fortunate nations. Population growth is slow and per capita income is very high. Food consumption is very high for most consumers and programs to improve nutrition for the poor are very large.

Our natural resources are of abundant high quality and have been made highly productive through investments in comprehensive research programs. This wasn't written by staffers and persons like myself. This was written by an independent agency. And they go on to talk about the future of our agriculture in the United States and echo many of the things you said in your opening remarks. The joint council also then has established some priorities.

They have established the agenda and we have set forth in the joint council that basic biotechnology research is the first priority. We find the young men and women and the scientists of today that are going out to maintain and increase the pace of the highest production ever seen in the history of the world.

What are they doing? They are studying things that are important to the next generation of reseachers. Our experimentstation in North Dakota is similar to the others. This is what is happening. They are studying the biotechnologies. They are studying genetic engineering, studying growth of plants at the cellular level and all this is building a basis for agricultural production in the year 2000 and beyond.

Sustaining soil productivity is our second priority, scientific expertise development is our third priority. Let's not forget higher education. As a dean, I was very disappointed to see that the House Appropriations Committee failed to say anything about higher education in the fiscal year 1985 bill.

How is it that in this great Nation we hear so much clamour about the poor quality of education and refuse to put the dollars out to make the job complete? Sure kindergarten to the eighth grade is important. Freshman to graduation in high school is important. College through the bachelors level is important. What is wrong with finishing off and getting people trained at the master level and Ph.D. and DVM and beyond?

I say it is high time that the agricultural appropriations bill supports higher education. Water Management is the joint Council's fourth priority, plant and animal—efficiency, including protection, is No. 5, human nutrition is sixth, information systems communications technology is seventh, policy analysis, market development is eight, and, of course, forest and range productivity is the last of our priorities. These priorities are established. The joint council is a forum and I believe it represents then the many issues, the many agencies and the many agency experimentation actions involved.

Mr. Chairman, and members of the committee, this concludes my rather broad remarks and my formal report is on record. And I would be happy to respond to any questions.

[The prepared statement of Mr. Lund appears at the conclusion of the hearing.]

Mr. **Brown**. You have made a very eloquent statement and of course the first thing that we cynical Members of Congress wonder about when we hear an eloquent statement like that is whether you are running for office or not.

Mr. **Lund**. I am just trying to maintain the one I have got.

Mr. **Brown**. I note that you are a member of the joint council and obviously have participated actively in it and you give an enthusiastic endorsement for the council activities and we are very interested in exploring that. We are very good at creating new institutions here and these institutions are very good at creating reports and you have shown us the reports.

We have a full menu of them up here, but really the test of when we have succeeded is when this has created a process which is actively assisting the progress of the field that we are concerned in, in this case agriculture.

Now you have been participating in this process. Do you see any weaknesses in it? Do you see any aspect of it that you feel are not serving the fundamental purpose of assisting the farmers and the farm policy makers of this country? Have we created too many demands for paperwork and for institutional existence and have we sacrificed something more important than that process?

Mr. **Lund**. I have always been a strong supporter of diversity, not only in the experiment station management, but also at any level of State and Federal Government. I believe this experiment in democracy in this country is a success because of three major sections in the Federal level of Government of this Nation.

I see nothing wrong with seeing different levels of input also in agricultural administration as far as the different agencies are concerned. I see nothing wrong with seeing the extension service having a plan for the 1980's, ARS having a 6-year plan and the joint council promoting the 5-year plan.

Also I see the National Association of State Universities and Land Grant Colleges also being interested in maintaining a presence and visibility in food and agriculture. I really believe many times we see duplication as a weakness. I really see it as experimentation and a strength. I don't think there are too many farms. I see nothing but advantages in diversity.

As I said, I started out in 1969 as an administrator trying to understand the CRIS system, struggling with it for over 10 years, seeing it struggle and fail many many times because you have all the information in the world, but you don't have a way to use it, to plan. And I see now the plan, the planning and using CRIS, then, as the base.

So I feel very good from what I see and, no, I don't see right now any functional weaknesses.

Mr. **Brown**. Is the CRIS system being adequately maintained? Does it contain all the information necessary, if properly organized to do an effective job of planning in the research field.

Mr. **Lund**. It is constantly being fine-tuned. I serve also on what they call the CRIS Operation Council, meet twice a year with Mr. John Myers, manager of the CRIS system and the National Agricultural Library staff and ARS staff that help manage it.

Yes, we made a lot of adjustments and certainly we always find that there are ways to improve it, but if we stick with the basics, the fundamental analysis which is based on the categories of activities and commodities and the resource benefits, then the information in CRIS is valuable.

Mr. **Brown**. Is the CRIS integrated with the National Agricultural Library operations? Is there a connection there?

Mr. **Lund**. Yes, sir, it is.

Mr. **Brown**. Mr. Roberts.

Mr. **Roberts**. Yes, thank you, Mr. Chairman. Thank you, Dr. Lund, for a very eloquent statement. I have been so busy out in my 58 counties, very similar to your country in regard to seeing how my farmers can stay in business, to the point that I haven't really done my homework on the 5-year plan and all of this business and I share your concern and sense of frustration about those who tend to think of us out in the High Plains as living in the great American desert.

We have members on the Agriculture Committee who tell me that we shouldn't be farming out there. My retort to them is we do farm out there as opposed to where they get all the rainfall and they simply put the seed in the ground.

I guess having made my speech, I am a candidate, Mr. Chairman. By the way, I want to follow up on the chairman's comments. We have got annual priorities, annual reports, and I must tell you in just skimming through this brand new publication, on the summary page, V, I am not sure anybody in the country wants this red disc that they could take into their elevator. Whether they get any credit or not, I think it is good long-term planning.

Could the system concentrate more on the adjustments of the priorities if there were fewer reports? You just made a statement that you said it was supplemental or the total effect of this was good, but are there too many annual reports in regard to the 5-year plan as opposed to adjusting the priorities to have an impact on the budget and the real world?

Mr. **Lund**. Really the most important thing is to establish the forum. Where is the agenda for agriculture? Really that report isn't meant for the country elevator, isn't meant for county agent. It is meant basically for the dean and college director to have substantiation and the persons above that. And the persons in charge of the State legislature, where 62 percent of the funding in our State comes from, I plan to use this as my way of convincing my State that the Federal Government does have an understanding. It does know where it is going in the direction of agricultural research.

So really we should not expect these reports to be much lower level than they are today. This is a forum. This is what we should be using them for.

Mr. Roberts. Has this kind of information been helpful to you in establishing those kinds of priorities during the very difficult budget time in the State legislature in your State?

Mr. Lund. I have had an advantage because I serve on the IR-5 CRIS Management Committee. This is an interregional committee which used the CRIS information as a planning tool. We have been at it about 5 years now. I had an advantage in using this in my own legislature. It is valuable and will be used more and more by State directors as they struggle with their board of regents and State legislatures. This is where it should be used.

Mr. Roberts. I have nothing further.

Mr. Brown. Mr. Gunderson.

Mr. Gunderson. Thank you, Mr. Chairman. I guess I want to pursue one question because I am concerned about your statement that this wasn't meant for the local elevator or for those kind of people. I sense that even in my district where I have two college campuses that are predominantly agriculture schools, I will tell you, I can't hold a public forum on those campuses because my constituents won't go on the campus and into a college building for a meeting.

I don't know if they are scared or if they are just estranged or whatever. Whenever I was in the State legislature and the issue of funding for the university system came up, everyone from the system would come before our committee hearings and tell us of the need for additional money. We would all tell them what they had to do to create a support base back among the people because the first thing the farmers and the constituents told us to cut was the university budget.

And I have got to tell you in all honesty, that when I look at this report and I get to the youth, family, and consumer programs and the area of human resources development, I see two goals and the objectives: One, to design programs to aid society in the development of human capital; and two, to develop positive behavioral programs for youth with programs such as 4-H.

If I were to go home to any one of the farm forums that I have in my counties and were to show them this, 95 percent of my farmers would say that is the first place you can cut the Federal budget. Now, that is a concern. How do we deal with it?

Mr. Lund. You can't do it alone.

Mr. Gunderson. Good.

Mr. Lund. It takes a little help and I can give you an example how to do this. You may have heard about Ole and Sven. Dr. Myron Johnsrud, director of extension in North Dakota, and I have adopted the personalities of these Norwegian characters during our travels around the State over the last 4 years.

We talked to over 600 people in 30 meetings, 18 to 20 people at a time. We talked about the need for research and extension. Two years ago the State of North Dakota went through a tremendous budget reduction, but we came home with 27 new positions and a

12½-percent increase in agricultural research and extension only because we told the people why 4-H is important; why mainstream agriculture is important to them.

They really got behind us and pulled. You talk to Mr. Byron Dorgan, our only lone Congressman from North Dakota, you will find he has heard about Ole and Sven. I think that is what you need. That is why you need people in your State to help you tell that story.

I will never back down from the importance of 4-H. What I can see is a young boy who comes to college. He stands in front of the banquet or stands in front of a committee and makes a statement. You swell up with pride. You know that kid came out of 4-H. He came out of a demonstration program. He came out of a speech-and-debate program. That is what makes it great and those are the leaders of the future.

Mr. Gunderson. That is a problem. I am all for 4-H. I was a member of 4-H, but I must tell you I am not sure we need research in 4-H. I am not sure we need research to tell us we need youth organizations. I think we have already figured that out.

Mr. Lund. How do you motivate young men and women? I don't think we know that, you see. I think there is plenty of research to be done. That is where education is part of it. The other comments about the farm elevator, here are the people I believe are the watchdogs. These are the men and women on the users advisory board, they are the ones that go out and talk to the local farm elevator.

They can talk to the local 4-H leader or person that is in charge of some small group in the county, the ones that are listening to what is going on at the grassroots level.

Mr. Gunderson. Thank you.

Mr. Roberts. Is there anything about price in this book and farm income?

Mr. Lund. One of the priorities has to do with marketing in the joint council, yes.

Mr. Roberts. I have got people that are coming to our meetings at the country elevator in 58 counties who are going broke. It isn't so much anymore whether we plan the transfer to that next younger generation of farmers that have been in 4-H, which is an outstanding program. And you will find no member of this committee unaware of the contributions by FFAA or 4-H or Boy Scouts or for that matter all of this effort.

The chairman here has been an outstanding leader in working for appropriate funding for all of those kinds of things. In regard to the educational effort, I must tell you the situation is tough and I know you know this by heart, up in your country. It isn't whether or not we get that next generation on board, it is can the current generation hang on long enough.

I think what my colleague is trying to say is that if I go out in my country now and say we need more money for Kansas State University, which stands next to motherhood, sunset, and John Wayne in my country, except when they play Nebraska, my farmers look at me and say I know all about those programs.

They are good programs. But, right now I need price and I think I must share my colleague's concern that if we do nothing but put out booklets filled with 35-cent word platitudes about these programs and don't address some specifics here, in regard to the farm price and cash flow and credit crunch, I worry about a lack of support, a lack of base support for these very fine programs that must take place, that must be ongoing.

Would you respond to that concern?

Mr. **Lund**. I believe if you were to visit with your farmers you would find that the interest cost of doing business is taking the profit out of farming. I think the biggest thing a person could do for the farming enterprise in any nation is reduce the cost of money.

There is no doubt that the farming enterprise would revive as soon as the price of money goes down.

Mr. **Roberts**. On the other side of that, in your testimony you have just indicated in terms of budget priority, that was my earlier question, do these reports—does this kind of work, does the CRIS effort, does the joint council give you the ammunition you need to make these kinds of budget priorities?

Even that comes before this subcommittee or for that matter full committee or any committee in Congress feels they are entitled to and can show that these are an investment and not a cost. But we are also entitled to pay the cost and cost of that is this growing budget deficit.

That is the reason we have the interest rates and that gets us back to square one. And in terms of tangible benefit, I really wonder if I hand this out to my farm organization whether or not they would rate this as a very top priority.

Mr. **Lund**. Farmers, of course, are interested in only thing, to make a profit. You make it by two different ways: either sell a few bushels at a lot of money or a lot of bushels at any price. There is a fixed price no matter where it is of the cost of doing business.

Take this Winrock report: it shows there are only 3 areas in the world in the next 25 years that will be in a position to export grain. So if the grain elevator operator is having trouble buying grain and managing it and making a business for himself, it is probably only a short-term affair. And I think that is basically something we manage by making interest rates lower.

I am looking at it as the long haul in agriculture. If you were to visit Europe you would discover they have what they call the 10-ton club over there. What does it mean? That means the average farmer in France and Northern Germany produces 8 to 10 tons of grain per hectare. What is the average wheat field in Kansas and North Dakota? Less than 2 tons per hectare.

Those people are way ahead of us. If our American farmers could provide 10 tons of grain per hectare, which is equivalent to 180 to 200 bushels an acre, they would sell that grain no matter what the price.

Mr. **Roberts**. We would have a surplus of about 5 billion bushels and the price of wheat would be $1.50 and we would be in worse shape.

Mr. **Lund**. There is a breakeven point in production lost per acre. Once this is exceeded, farmers can make a profit at almost any price level.

Mr. **Roberts**. I can understand that and I don't want to become argumentative and I am playing the devil's advocate, if you will, and I would only make the observation that we have had a lot of rural development programs. And I guess this comes under the heading of rural development. And I can remember back in the mid-1970's when we were talking about the various means of rural development and long-term planning.

If you get the price up where it should be, in terms of farm income, you will reverse that out-migration. You will have people waiting in line up in North Dakota and Kansas and Nebraska. Our towns will again start to thrive. The best rural development program I know of is farm income.

We are not at odds. I just want to make sure what you are doing on the joint council is transferring in such a way that we have a broad-based support for what you are trying to do during a difficult time.

Mr. **Lund**. I would like to repeat my first statement that we now have an agenda and a forum for agriculture in the joint council.

Mr. **Brown**. Dr. Lund, you have been very helpful to me and the other members here this morning in giving us a prospective of this. And since I understand this is your first visit to a committee, I hope that it has been of some benefit to you, as you can easily see what we do here is go through a constant process of soul searching to see if we are moving in the right direction and our discussion often goes from extremes.

If we have a situation in which we have strong leadership and good action programs, then we wonder why we don't have better plans to begin guiding their action programs and so we begin to develop good plans. And it looks like we now have plans to act on. Why can't we have good Federal leadership and strong action? And we keep oscillating back and forth between these, hoping to find some balance that will give us the best program for the country.

I think you have made a real contribution to our understanding of this. Thank you very much for your appearance.

Mr. **Lund**. Thank you.

Mr. **Brown**. Next I would like to call two witnesses as a panel: Dr. James Nichols who is dean of agriculture and director of the experiment station at VPI; and Dr. Neville Clarke, director of experiment station at Texas A&M.

Each of these gentlemen represents an important institutional segment of agriculture and we are very pleased to have both of you here this morning. We would like to hear each of you present your statement and then we will have a little discussion of your statement.

Do you want to proceed, Dr. Nichols?

STATEMENT OF JAMES NICHOLS, DEAN, COLLEGE OF AGRICULTURE AND LIFE SCIENCES, VIRGINIA POLYTECHNICAL INSTITUTE AND STATE UNIVERSITIES; CHAIRMAN, DIVISION OF AGRICULTURE, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES

Mr. **Nichols**. Thank you, Mr. Chairman. Thanks to the subcommittee. You have my written statement before you.

Mr. **Brown**. The full statement will appear in the record.

Mr. **Nichols**. I will not, in the interest of time, make specific reference to that, nor will I read it.

It is a privilege to be here again and it is a privilege to have an opportunity to commend again this committee for your activities, because I think you are providing a great service for American agriculture and specifically for U.S. agricultural policy.

You people in this committee have heard and read and know about the importance and problems and opportunities and the challenges and the complexities and the realities of this system that support agriculture, American agriculture. And you don't need me to repeat that here.

However, I would like to say that we are in your debt, the system is in your debt for allowing us to address some criticisms and some perceptions of the system that really do need to be looked at by us and by those that are supporting us.

Somehow it seems to me American agricultural policy has to address the question of, we must somehow sustain the capacity and the viability of American agriculture in the short run and establish policy which takes short-run politics out of the long-run, long-range future of American agriculture. How we go about doing that is, unfortunately, your responsibility and perhaps not our responsibility. But we will make you a promise. We will make an alliance with the Congress. This system that we call the land-grant system of agricultural research, education, and extension ain't broke. It ain't broke, but it does have some broken parts and it does need a little grease, a little oil, and a little fuel.

That alliance is, if some way somehow we can have the wherewithal, the opportunity and the barriers can be removed to permit the productive capacity of American agriculture to proceed in the short run and sustain the economic viability of American agriculture today so that there can be an economic future, then we will—this institution will provide the human capital, the training for the human capital, and we will provide the wherewithal, the extension know-how, the research information that is so specifically necessary to sustain the system.

I have about three or four brief comments that I would like to make and that is this: When we talk about new technology, new information, we do start with human capital and investments in human capital. You have heard that one before. We have a little bit of a problem, though, in addressing the generic sense of the problem of American agriculture, and to stress that at the State level, there is one set of problems, and at the Federal level there is a set of problems. State legislators understand, for example, that applied research investments have more immediate and sure returns to the State than does basic fundamental research.

Basic research is risky. Benefits spill over into other States. Thus, without adequate Federal support to compensate particularly for the spillover of benefits across State lines, there is a strong disincentive for States to invest in basic research, because applied research is less effective without basic research, those research programs suffer as well and the quality of teaching and extension suffers. There is a specific role and a very targeted role for the Federal Government to support basic fundamental knowledge through basic research in biotechnology, et cetera, which the States have a responsibility to do, but will not do to the same extent, to the same degree that the Federal Government can, because the State wants to support research that will be in the short-run interest of that State's agriculture, and that is vital and critical.

There is another part of the system that needs to be stressed, I think, and that is this approach to interdisciplinary research or team research. A single scientist is not going to make a great impact on American agriculture, if you will. It will take an interdisciplinary team. The difficulty is how do we bring that to bear because the system does not permit the rewards for individuals within that team effort to address those kinds of problems that are outside a particular discipline, so we need to stress that interdisciplinary research is needed to solve many of our problems, but seldom do funds come through grants supported to interdisciplinary teams.

Most NSF grants and NIH grants are made to individuals. They are not made to a team of scientists to address a broader kind of problem.

I think that there are many, many critical issues in the public policy arena as well as the national resource base and the conservation, the importance of the conservation of that national resource base and how that is to be paid for and what incentives are there for farmers in the public interest to practice conservation measures.

Research on new biotechnology and information technology must also extend beyond the technical questions and consider institutional changes needed to ensure the society as a whole benefits and not just a few very large farmers and agribusiness firms.

I will quit with that and make the point again that the States' interests are with the immediate problems of today. They must be today. The States' interests are with the kind of agriculture that resides in that particular State. But the national interests must be with the long run as well as the short run, but more importantly, with the long run and only in that context, I think can we really address some of those particular problems.

I also think that it must be made known again that agricultural research and education, the system, the land-grant system and all the systems that feed into that, are not solely for the benefit of agribusiness or farmers. It is in the public interest. Otherwise, you gentlemen would not be proposing funds to support those programs. So it is in the public interest and we have less difficulty convincing our State legislators and the public about those kinds of things and the reasons where agricultural research and education should be supported and why agriculture should be retained and survive as a viable entity in that State.

They understand that sometimes better than farmers do. So it is in the public interest and that needs to continually be made known and it is also bigger than just farming. We are here to assist in any way we can.

Thank you.

[The prepared statement of Mr. Nichols appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you, Dr. Nichols. Next I would like to hear from Dr. Clarke representing ESCOP.

STATEMENT OF NEVILLE P. CLARKE, CHAIRMAN, EXPERIMENT STATION COMMITTEE ON ORGANIZATION AND POLICY

Mr. **Clarke**. Thank you for the chance to speak to you for the Experiment Station Committee on Organization and Policy.

I call to your attention the document that Dr. Lund held up earlier this morning—"Research 1984, The State Agricultural Experiment Stations." This represents a contemporary Statement of the role of the agricultural experiment stations in the total agricultural research system. It addresses our perceptions of how the process of planning and setting the priorities is undertaken today and it outlines what we see as the aggregate national research agenda and our part in that research agenda.

If I could sort of summarize and speak extemporaneously about my comments this morning, I will leave the written testimony for the record.

If I could depart from my intended comments to express thanks to you, Mr. Chairman, for what you did yesterday in illuminating the need for the biotechnology initiative and the strong support that that is going to give the process later in the session. It will mean a lot to us what you did, and we are appreciative of that, sir.

Mr. **Brown**. I appreciate your remarks. I think the experience was constructive, although one can never be sure until one sees the results. But I envision this process as one that will continue. You know the history of the competitive grants program, and now the biotechnology initiative, which is a part of that. They have met some resistance in part because Members of Congress have been slow to understand the importance of it, and I think we are pretty much united now in the agricultural research community and among those Members of Congress who follow the situation closely on the importance of going ahead with this. Certainly the administration is behind it, and I expect to see success achieved here. I expect to see us have a good flourishing program and this will at least allow us to get off to a reasonable start, even if not as much as we might like.

Mr. **Clarke**. Thank you, sir.

The document that I mentioned earlier speaks in its early part about the base programs of research that are conducted out in the 50 States and I would like to place those in the context of the national agenda for agricultural research by saying that those base programs are more or less site specific. They do address the problems of individual States and regions within the States. They are characterized by substantial diversity and site specificity. They have the opportunity, I believe, for early problem recognition and for early responsiveness and they have, as a result of a very broad base of continuing operations, the ability to generate and identify the new research initiatives that need to emerge from the base program.

Many of these new initiatives are solved at the local or State level, but a number of them are more pervasive in their implications in the individual States and some of them are broader than individual States can undertaken.

I perceive that those rather broad issues are beginning to be aggregated by the joint council at the national level. The process of aggregation tends to obscure the specificity of the research in addressing the regional problems of the States. Part of the problem of establishing a research agenda at the national level is dealing with the fact that we have basically, through the necessary process of aggregation, a loss of visibility of the kinds of things that specifically address some of the problems that Mr. Roberts and others addressed this morning.

As we look ahead where we are going with the process of defining the research agenda in the State agricultural experiment stations, there are a number of external factors that are motivating change. I have titled the presentation "The State Agricultural Experiment Stations in Transition," as a macroeconomic environment having to do with the cost of money, world trade policies and the like, some of which we have little opportunity to do anything about in an agricultural research community, but I would suggest that without being able to change those macroeconomic factors, our research needs to address the response that agriculture must take to these external factors and be able to deal with them in a contemporary way.

We continue to be concerned about a dwindling supply of natural resources and even in times of severe economic pressure have to be concerned about the management of those natural resources. We have a changing clientele in agriculture. One of the new groups of clientele is the person who still works in the city but lives in the country because of his choice of a place to live. That group of individuals is using agricultural resources, will use a considerably larger number of them in the future, and we have the responsibility to make sure that the resources they use contribute in the best way possible to the production of food.

We have the problem of current surpluses that I would like to address in more detail later that is certainly a factor in motivating change; a continuing concern for the quality and safety of our food and an increasing concern for the quality of the environment. Those are some of the factors that are motivating change. To take the other side of the coin, there are things that can enable that change to occur in the experiment stations and in the research community in general for agriculture.

The first thing that we would say in that sense is we need to continue to maintain the strength and the dynamic nature of the base programs of agricultural research out in the States. That group of research activities that in the aggregate determine the ability to respond to timely changes in priorities and needs, and builds the base for agriculture to work on these, recognizes that agriculture itself is highly diversified and site specific. The resources that are necessary to continue these new initiatives have been talked about to some extent this morning and in particular the biotechnology initiative is one in which we felt a considerable amount of across-the-board support as you have just spoken to, Mr. Brown.

We do understand the consensus that we have for this new initiative is very broad indeed and that the markup of the appropriations committee was disappointing to the land-grant community in that you wind up with only about a $2.5 million increase for competitive grants across the board. We hope to do a better job in our community of providing the kind of information that will allow the Congress to have a more favorable attitude about the problems and we feel we should continue to help in any way we can to make the advantages of this opportunity more apparent.

Another thing we believe can be done, particularly through the competitive grants program, is to provide a broader involvement of the scientific community in the problems of food and agriculture by involving colleges and parts of the academic institutions outside agriculture and go and find the science where it is and make the best possible use of it by working broadly with the larger scientific community to provide the opportunity to take advantage of the new technology.

We have heard several people speak about the importance of interdisciplinary research. I believe the competitive grants program as envisioned would allow considerable enhancement of multidisciplinary activity.

We were asked in preparation for this testimony to give some thought to the process that is emerging now of doing a better job of planning and particularly of making sure that we are doing the most effective job that we can of setting priorities. As several others testified this morning, the present system that we use has a number of strengths to it. However, we all know that it is far from perfect. We believe that it is going to be possible through the process that is underway now to do a better job of focusing on the priorities at the national level to try to recognize that while we can't deal with the detail that is necessary to be precise in showing exactly how we are going to address problems of the specific regions of the various States that by a process of aggregating pervasive issues and bringing them to the national level that we will be able to do a better job of dealing with relative priorities at this level.

The joint council is doing a good job and has only recently begun to do an effective job of taking advantage of the opportunities that the farm bill provides for moving ahead with this planning process. With regard to dealing with economic analyses and critical path analyses and helping set this priority process, one of the things that we are a little bit concerned about is that we don't overuse those kinds of techniques in planning some of the early directions that are undertaken for agriculture.

There are some elements of scientific research that don't lend themselves well in their early stages to a critical pathway analysis. There are two kinds of thinking that we use about planning for agriculture. One is to ask our scientists to help us think about opportunities and the other is to ask our agricultural clientele to help us define what the needs are. We try to comingle the statement of needs and the statement of opportunities in such a way that we can get the best bang for the total dollar that we have. It is unfortunate but true that research is inherently not an efficient process. If we knew what the answers were going to be in research, we would be calling it something other than research.

There are a number of areas of science in which applying the kind of trend analysis that we are talking about here will help us quantitate things that we already know in concept to be so, but which won't provide us any fundamentally new information.

I believe there is a strong place in the total system for doing the kind of thinking that allows us to know why we are doing research and where we are going with it as long as we provide the flexibility at the scientist level to do that sort of thing. We believe at the State level this process is being done effectively. Otherwise, we wouldn't be gaining the resources that we need from the State system.

We believe that the aggregate planning we have to do at the national level and the difficulty of obscuring specific issues by talking in generalities is the problem that we need to place more emphasis on. The Experiment Station's Committee on Organization and Policy at the present time is trying to develop an improved methodology for that translation process, a better method of bringing the very detailed research agenda from the State level into a better and sharper focus at the national level without overwhelming the national system with excessive detail.

We believe that we will need to be more effective as the Organization of State Agricultural Experiment Stations in providing this better statement of priorities in order to be better members of the total community that contributes to the thinking of the joint council.

We were asked to give some consideration to the impact on joint council research planning that the present supply and demand projections have in the way of program implementation. And that is a difficult question to answer in the short run and an answer that perhaps is somewhat different if you look to the long run.

The economists in our experiment station that provide advice to me in this area—I know that Ken Farrell in testifying will do a more eloquent job than I of this and perhaps take a different position—but as we look at it, the food supply excess that we have in the world today is not nearly as great as the excess supplies that we have on hand in this country. To some degree, the national policies that exist today, policies that have to do with trade and the value of the dollar, the debt in other countries and the like, limit our capability to export the products that we produce in this country today.

The presently perceived glut that we have in some storable commodities could turn in a relatively short time, we believe, to a marginal ability to produce food. If we continue to have the kind of adverse weather situations that we have had for the last couple of years in many parts of this country in our view, we could see approaching shortfalls in some of the major commodities such as cotton, corn, and perhaps rice.

Perhaps the most compelling reason for continuing to push very hard for agricultural research at this particular time is one which comes back to the basic issue of maintaining a competitive position for agricultural production people in the world today—our position of the U.S. farmer in the world today. The ability to compete in the marketplace, the research that is needed to drive down production costs so that our farmers can be more effective competitors is one which we believe to be very compelling in the short run.

There are a number of new technologies that are emerging in the next very short interval of time that we think will continue to contribute to the increasing competitive ability of farmers in this country. We believe that that same kind of capability, reducing the cost of inputs, doing a better job of managing, doing a better job of using natural resources, will have a considerable utility downstream in the 15-to-20-year timeframe when we do need to start producing increasing amounts of food to take care of world food needs.

The background documentation for this hearing, prepared by staff for the last question is about using natural resources more effectively and more concern for the environment in production agriculture as we look ahead. We believe that the new reports that you have before you show exciting opportunities to move in that direction.

The biotechnology initiative, for example, will offer some major opportunities in biological pesticide control that will not only be very helpful in terms of reducing economic cost of inputs to farmers, but will have at the same time a very desirable effect on the quality of the environment as a whole.

The impact of the emerging new technologies on farm structure is another point that we were asked to give consideration to in testimony.

The concern I believe is that many of the new technologies will in fact provide benefits for the larger agricultural enterprises at the expense of the smaller agricultural operator. This is an area that we certainly agree needs to have continuing examination and needs—I am sure that our community needs external advice on looking at the effects of emerging technologies on the total population, including the consumer of food.

We would say, and I know that you gentlemen are more than aware of this, that there has been a continuing evolution of farm structure all through modern agriculture. Most people who are expert in this area seem to say that this evolution will continue. I have already spoken to the fact that there is a new clientele emerging in agriculture in addition to the traditional clientele, and that is the urban farmer, the person who works in town and lives on the farm.

Concerns about the family farm and the small farm will continue we believe to have to be addressed. I don't know that we have anything like all of the answers, but I believe that much of the new technology that is being developed today can be used by broad segments of agriculture, is not restricted to the use of the large farmer and that the major long pole in the tent making this possible will be the education process that is provided to make the smaller operator aware of the opportunities that are available to them.

For instance in the area of computer technology, it wouldn't be the cost of software or the cost of hardware that will set the pace for the use of computers in agriculture. It will be the education of the user that will determine that use.

There are a number of decision aids in this general vein: market information, all of these kinds of things that can be used with modern computers today offer us astonishing opportunities in a relatively short time to provide improved capability for management in agriculture in the United States, a capability that we believe will be useful in this survival plan for the few years ahead as we move down towards the turn of the century.

As we finished our document and tried to talk about the research agenda ahead, we found ourselves also dealing with a fairly broad statement lacking in specifics, but just since we were a part of the total joint council planning process, it is not surprising that the initiatives that the experiment stations have identified have a very close correspondence to those in the joint council documentation.

The biotechnology initiative is endorsed strongly by us. The opportunities to use electronic technology in agriculture, not just computers but related technology, the concern for natural resources and safety of food and environment are also areas of research agenda that we see in the future and we see an urgent need for an expanded program of agricultural policy in foreign trade in order to try to answer some of the questions posed earlier this morning.

In summary, I would like to make four points that summarizes what I have been trying to say in the last few minutes.

First, that the base programs in the State agricultural experiment stations are a continuing national resource and that they will continue to be important in the future; that the decentralized system for agricultural research in this country represents a strength and not a weakness. We hope that we can continue to encourage the kind of planning at the grass roots level that allows us to be very precise and specific about meeting the needs of agriculture in the individual States and yet, at the same time, devote more attention and do a better job of crisply identifying the broader national issues that should be brought to the Congress for continued consideration for funding at your level.

Number three, the state agricultural experiment stations are in a substantial state of metamorphis today. I hope that we are keeping the best part of this well-established system that has served us so well in the past, but we are moving to take advantage of such things as the new opportunities in the biological sciences and some of the new opportunities that present themselves with computers and other techniques that will allow us to provide support for our agricultural clientele out in the States.

We look ahead to times as we deal with—as we know that you must deal with, the increasing concern for our national debt and realize that as we talk about the agenda for future agricultural research that we have to take into account the tough job that we all have of talking about the resources that it takes to do the job. We believe that the programs that we have presented here that we know that you are so familiar with are part of the solution and not part of the problem.

We believe that these resources that are being sought for such things as the biotechnology initiative will have what has been—will continue to have, as they have in the past, a very substantial return on investment. We know that you are familiar with the number of analyses that have shown that agricultural research has a return on investment of somewhere between 30 and 50 percent per year and we believe that the opportunities presented by some of the newer biotechnology areas of science and the like could do that and more in the years ahead.

Mr. Chairman, thank you for the chance to make these comments.

[The prepared statement of Mr. Clarke appears at the conclusion of the hearing.]

Mr. BROWN. Thank you, Dr. Clarke. That is an excellent statement.

Mr. Roberts.

Mr. ROBERTS. Yes, Mr. Chairman.

I want to second your comments about the statement given by Dr. Clarke and also by Dr. Nichols. We have three fine witnesses who have testified before us this morning and their statements have been very helpful. I think your testimony has been most positive and I would like to go on record as saying the economic returns on agricultural research merit a much larger investment. I say that knowing the facts of the budget situation, but I want to go on record as saying that, having been a little bushy-tailed and critical before.

Have either of you gentlemen seen any benefit, any real benefit from this kind of planning effort given the budget restraints that we have to work with? I would imagine that the best 5-year plan in the world brought together by your collective minds and all the expertise of the folks you have to work with would be just put together just about the time when we get into the monkey wrench business with the budget. Has this been helpful to you despite the budget restraint?

Mr. CLARKE. I believe that the way that the formula funds for agricultural research and extension have come to us over the years—I will speak to the research side—a requirement for examining together the agenda for actually expending some 25 percent of our research funds from the formula on a regional basis, that that as well as this joint council and ESCOP planning process has caused throughout the cascading thinking that goes from the State level to the regional level to the national level thinking about the point that you are making.

It has been addressed in our Southern Association of Experiment Station Directors the way you said it. We want to take the most positive view for looking for resources that it takes to get the job done, but let's take the planning process and let's identify those things that we can do better together as a result of the planning process with the existing resources. So it is the drive towards looking for ways to collaborate, looking for ways to reduce duplication and looking for the critical pathway that this planning process does that is beneficial to an existing as well as to an expanding budget.

Mr. ROBERTS. Do you have any comments on that, Dr. Nichols?

Mr. NICHOLS. Yes. I think it has been useful, but where it has been the most useful has been in raising the right kinds of questions at the local level, the questions of interdisciplinary research, the questions of payoff, the questions of prioritization, who participates in that and the questions of the short run and the long run and the impacts of agriculture in that State on the public. Those are the kinds of things that surface, those kinds of issues and those kinds of questions.

I think the end result has been the recognition of the importance of this effort to the public both at the State and national level, and also the recognition of the limits in the resource base and the necessity to plan better. I don't know that the priorities necessarily would be just picked up and adopted per se. Certainly they wouldn't be for any State, but it has helped in the process, yes.

Mr. **Roberts**. I would like to follow up on your short-term/long-term statement that you made not only in response to this question, but in your earlier statement.

I am intrigued—well, obviously all of us know that we would like to take short-term politics out of agriculture program policy deliberations and get to a more predictable system and a long-term agriculture policy. I have a governor of my state who wants to set up a Federal reserve board of agriculture, so to speak, and have 15 members on this board and to recommend to the President and to the Congress long-term objectives, also to point out that many times when we go down the road of protectionism or embargoes, we end up in the ditch and that we shouldn't do that, and that hindsight is always 20-20.

I don't know if that is possible. I wish it were, but it just took us 18 months to get a farm program past this Congress that gave my people an acreage base with which they could participate and we were able to put a cap on some of this spending in terms of our farm program outlays.

Do you have any ideas of how we could accomplish this? I have every confidence that the agriculture research system will endure and with various members of the iron triangle that is so highly publicized around this place that you will be fine and you will have another 5-year program and you will be doing your work and Congressman will come and go, but I am not too sure about the farmer/stockman. I am not sure he will be out there that long in terms of the profit situation we are facing.

Do you have any specific recommendations along this line?

Mr. **Nichols**. No specifics other than to underscore the absolute importance and necessity to do that, even if it is maybe not possible for us acting alone. And I think that the benefits to be accrued are the forums at the local level and with Congress and with the States and with the producing farmers and with the consuming public. The fundamental basic importance of food and fiber in this world to that local site, to that Nation and to the Government's food and agricultural policy must result in a goal of a more productive, a more profitable, a more efficient agriculture that protects our natural resource base and our environment and yields the kind of equitable returns to producers in your State and in my State and does not cost the taxpayer an enormous sum of money.

The fact that we still have the most equitable food cost and the best quality in the world here, there is some reason for that. Aside from natural resources, aside from climates and other physical constraints, I think we need to find some specific needs and opportunities and I think we have people now that are addressing it. We are talking to our legislators, our Congressmen and we are talking to others about these kinds of things.

I think we have some bright young minds. Talk about the human capital, we have got some very bright young men and women in this system that can contribute ideas to solve those kinds of questions. I think that is a fundamental question that you pose. I don't have the answer, but I think we need to be searching for the answer.

Mr. Clarke. If I may add to that.

As I perceive the activity going on in agricultural policy research in the land-grant community today, there are a couple of things that are new that are important, I believe, that get at this problem. There is a very substantial increase in the amount of effort that is going into looking at the macroeconomic situation in the country and in the world and trying to relate agricultural problems to a larger environment. And the second thing is that in that context people in this area of research are beginning to focus on farm policy statements for the set-aside programs and the like, looking at the implications of a wide diversity of these kinds of programs, not trying to bring to you a jelled-out policy and say exactly what that policy should be, but trying to develop a meaningful and quantitative assessment of what the impact of various alternatives, judgments on your part might be.

I hope we are coming to grips with that in a more realistic way in the land-grant community.

Mr. Roberts. They did that at the University of Missouri, as my colleague pointed out on the House floor yesterday. $450,000 was proposed to go to Tiger land as opposed to Texas A&M land. Figure that out. Step two is Texas A&M, Kansas State, Nebraska, Notre Dame, and also Virginia. It is the macromicro thing that I think is so terribly important. Certainly we need all the help we can get with regard to advice and counsel in this respect. I think that is one of the responsibilities and obligations that you folks have and I am delighted to see you on the playing field as opposed to being on the sidelines and we need to get your track suit on and your shoes and get you in the action.

Can you tell me why we won't have a shortfall of wheat? Tell me we have a shortfall of wheat. You mentioned corn and soybeans—where is my shortfall in wheat so I can get a price?

Mr. Clarke. Down the road a ways, sir.

Mr. Roberts. That is what I was afraid of. You are talking about the future in high tech that Dr. Lund's 4-H youngster who comes onboard, and yesterday we had a witness saying there is a golden age of agriculture coming with supply and demand and we are on the crest of this new high tech wave of information. I believe that, but it worries me that all we hear is Chicken Little speeches out in farm country and the doom and gloom.

Are we really on the threshold of a decade where the farmer can make a reasonable profit and expediting things that are happening in biotech and high tech and communications, all the things that you are talking about? Give me a little optimism.

Mr. Clarke. I feel that the situation that farmers are facing today is not a situation that is going to get an awful lot better in the next 1, 2 or perhaps 3 years. The contributions of research to this immediate problem area are going to have to be directed very much to the problems at the local level to try to do what we can through research to reduce the cost of inputs and to develop better management strategies and I believe that the longer-term research program that we have been talking about for the last day or two needs to be placed in that perspective.

The biotechnology initiative is an initiative in basic research. The reason that it is contemporary today is because we have coming into focus an opportunity in biology that will apply very strongly to agriculture. Some of the biotechnology initiative—for instance, if you look over in the animal health area—has the prospect of paying off almost immediately. I believe that within the next 1 or 2 years, we will have better vaccines and diagnostic tools that will allow us to address the serious problem of brucellosis. We believe we will be able to develop a vaccine for that very soon.

The ability to greatly improve crop plants through recombinant DNA techniques is down the road, but the advantages are so great when you get there, you can't afford not to start now.

Mr. **Roberts**. What is not down the road aways is a vote, Mr. Chairman.

I yield back.

Mr. **Nichols**. Could I add about 30 seconds to respond to your question, if I might, Mr. Roberts, on that optimism for the future in American agriculture in the short run?

Mr. **Roberts**. Yes.

Mr. **Nichols**. One of the reasons that I am optimistic about the short run is the knowledge that these young men and women that have graduated from this system in the past few years are aware of these kinds of issues, these kinds of questions. They are smart, understanding. They have chosen these fields. They can compete in other fields. They are coping and they shall cope and I feel confident about that.

Mr. **Brown**. Mr. Volkmer.

Mr. **Volkmer**. Thank you, Mr. Chairman. I do have several questions.

The first is, as one who has been watching agriculture experiment stations operate for a good many years, it is good to see in your testimony that you are talking about becoming more proactive rather than just reactive. The basic question concerns what I see in the coming years, even for this year for 1985 on the budget end is kind of a stable budget. You really are not going to have increased funding. Can you continue to be more innovative, proactive with that type of budget?

Mr. **Clarke**. Not as well as we could with a more positive attitude like the chairman was trying to put forth yesterday.

Mr. **Volkmer**. Are you going to become stagnant?

Mr. **Clarke**. Not seriously so. I think the process has to be one of continuing to sort and sift and put together the most creative kind of attack that we can with whatever resources are available. It is much easier to be proactive with a proactive budget, but you have to be proactive under whatever conditions present themselves.

Mr. **Nichols**. I think the states individually are responding quicker than the Federal Government is. If you look at our State and other States represented here, they did increase our appropriations for agricultural research. In the short run, that helps, but in this matter of basic applied, site-specific state-specific kinds of interest, that is what the States are interested in, and so the long haul, the long-term technology, biotechnology needs to be funded in a more significant way at the Federal level.

Mr. **Volkmer**. Correct me if I am wrong, but basically in the past, the research that has been ongoing at the agricultural experiment stations has been basically connected with either livestock, dairy or plant. Is that correct?

Mr. **Clarke**. Well, the programs in the State agricultural experiment stations are quite broad. They would be in areas like human nutrition and food and development.

Mr. **Volkmer**. But nothing compared with what you just mentioned earlier today, on macroeconomics and the effect——

Mr. **Clarke**. There have been programs in agricultural economics throughout most of the agricultural experiment stations. A State like ours deals with 60 commodities being economically important in the State. We have to take a cross cut on that with natural resources, economics and so on. That is the base program of agricultural research that I spoke about earlier. That very broad infrastructure looking at this area is in place. There is some work going on in biotechnology in the State agricultural experiment stations. Dr. Charles Hanstrom of the University of California at Davis has done an indepth study that identified the total resource that is presently being devoted to this area of research in the land-grant institutions and it is substantial.

It is important to say that because that says that there is an infrastructure there that can absorb the kinds of new funds that we are talking about and make effective use of them in the short run.

Mr. **Volkmer**. My last question, before we go vote, is about how much emphasis, would you say, has been done in the area of reducing the cost of production, whether it is in, as you mentioned, new vaccines for livestock but also in crop production, et cetera, how much would you estimate has been done overall with regard to that area?

Mr. **Clarke**. As a percentage of the——

Mr. **Volkmer**. Of the total effort.

Mr. **Clarke**. With the existing programs or with the——

Mr. **Volkmer**. Yes.

Mr. **Clarke**. I can't give you a precise number on that. I don't believe that there has been an attempt made to slice the pie exactly that way. The shift that has occurred in the last 2 or 3 years in that direction has been very substantial. I would say that that shift away from trying to maximize the yields and shifting over to maximizing economic returns through reducing costs is an evolution that would encompass at least 30 or 40 percent of our total programs.

Mr. **Nichols**. We are not doing enough of that, but Dr. Clarke is right, it is moving that way.

Mr. **Volkmer**. Thank you, Mr. Chairman.

Mr. **Brown**. I am going to continue without voting. I don't have a perfect record anyway. If you could return, we would appreciate it.

Mr. **Volkmer**. I will be back.

Mr. **Brown**. I think it is clear, gentlemen, that you have helped considerably in improving the understanding of the committee members. Some of us have different areas which we stress. I tend to focus a little bit more on fundamental research guided by a concern for improvement in the quality of productivity of our operations. Mr. *Roberts speaks with much more concern, and this isn't* contradictory, about the welfare of the individual farmers in maintaining the profitability of the producers in the field. These are not contradictory, but they get tied together in the areas which you have indicated in your National Agricultural Research Agenda in this book around the issues of agricultural policy and foreign trade and the analysis of price and income policy in foreign trade, and I have a feeling that we are going to need more input in those areas than we have had in the past and that next year is particularly critical for that.

I think we are going to move ahead fairly well in the support of some of these other opportunity areas. I am fairly confident that we will, but the area of policy as it relates to the macroeconomic situation, the world market situation, is one that is very difficult for us because it is intertwined with broader economic and foreign policy issues.

Now, we have got to recognize that and deal with it in some effective way, and if I might just ask you, I am going to ask you to comment. I am going to advise you to make a special effort during the next year to prepare yourself to give the Congress some additional input in that area and ask you if you see this as something that you can realistically do. I am not asking you to do the whole job. We are going to get input from a multitude of sources, including competing commodity groups, competing portions of the overall agricultural industry.

I am trying to distinguish between the producers and the big agricultural exporters. They have different views on these issues. We are going to have all that input. We need to tie it all together and we need the input that you gentlemen represent not because you are the whole picture, but because if you don't give us your strongest possible effort you are going to get left out of the whole picture and we don't want that to happen.

Mr. Nichols. One of the things, Mr. Chairman, that I think is relevant to that point, and I think the community would welcome that opportunity, we, as you know, have been actively involved in international agricultural programs and agricultural development programs through U.S. aid and other types of programs that already have liaisons and consortia established with some of the developing Third World as well as developing countries so it is in that context that I think our faculty have already been brought face to face with that. Therefore, they don't speak from a point of theoretical types of things, but rather from a practice today, we have been there, we know.

So the kind of studies that need to be brought to bear can be done within that community of expertise.

Mr. Brown. There has been an illusion that has been cultivated in some places, including some of us in Congress that maybe the solution to our agricultural problem is all out production for this huge global market and we need to have a more sophisticated view of that situation than we have had in the past to see what is in our best interest here. That is a difficult situation to define as you know and we are going to have to take some policy steps on that.

Gentlemen, I appreciate your contributions very much. We will continue to be in touch with you, of course, and look forward to hearing more from you.

I would like to call Dr. Farrell at this point. Dr. Farrell is director of the National Center for Food and Agricultural Policy, Resources for the Future, and has, of course, published widely in the field of agricultural policy and I particularly appreciate the fact that he looks at the big picture.

Dr. Farrell.

STATEMENT OF KENNETH R. FARRELL, DIRECTOR, NATIONAL CENTER FOR FOOD AND AGRICULTURAL POLICY, RESOURCES FOR THE FUTURE

Mr. **Farrell**. Thank you, Mr. Chairman.

I welcome this opportunity to discuss very briefly the implications of a report prepared at RFF, entitled "Meeting Future Needs for U.S. Food Fiber and Forest Products". That report was prepared in 1983 under contract with the U.S. Department of Agriculture as a part of the needs assessment that you have been discussing this morning conducted by the Joint Council on Food and Agricultural Sciences.

Our report is included in its entirety in the joint council reference document, so I am not going to spend a lot of time summarizing what has already been published. My written statement, which I have submitted previously for this morning, is limited to two aspects of the report. One, some discussion of the methodology and the reliability of the projections that are in the report, projections pertaining to supply, demand and trade for major food, fiber and forest products, and some brief discussion of the principal conclusions and implications for long-term research and education planning of elements of our report. And then in the final part of my statement, I have some general observations on the usefulness of economic projections and what have been referred to earlier as critical path analyses for research planning and priority setting.

I think, Mr. Chairman, I will not read the statement but rather just briefly point out what is in it and then if there are questions from you or the members of the committee, I would prefer to address those rather than reading the statement per se.

The report which we prepared was focused on two major questions: First, what are the likely levels of effective or, if you will, commercial demand for U.S. food, fiber, and forest products by the years 2000 and 2020 and second, what are the likely capabilities of the United States to respond to such demands and what are the implications of those responses?

In approaching the first question, it was necessary for us to examine not only the demand prospects for food, fiber, and forest products in the United States, but also demand and supply prospects for such commodities in other regions of the world as an indirect means of assessing the potential export demand for U.S. commodities in the future.

Effective or commercial market demand was treated as being determined by three principal factors, one population and population growth; two, consumer income and consumer income changes in the future; and three, very importantly, national policies which affect not only population and income growth, but govern or strongly influence the price of food, fiber, and forest products and their mobility through trade.

On the supply side, the availability of food and fiber and forest products also was viewed as being primarily dependent upon three factors: First, the quantity and quality of the land area and other natural resources that were available for production of those commodities; crops, livestock, and forestry products.

Second, the availability of technology and how that technology would affect resulting crop, livestock, and forest product yields.

Third, once again, the nature of national policies which affect resource development, research and technology, availability of production inputs and the economic incentives for farmers to invest in the production of food and fiber at home and abroad.

We did this sort of an analysis for some 12 regions of the world in which countries were grouped on the basis of geographical proximity and similarity of economic systems. We looked at commodities in terms of major groupings of commodities, not each individual commodity, but those groupings including cereal grains, oil seeds, fibers, and livestock, products of meat and milk.

I want to express that, as I said earlier, our study focused upon what we have called effective or commercial demand and to note that that does not mean that the needs, that the food needs of all the world's population will be met because in fact there are many people in the developing parts of the world that function or are not operating within the commercial market system, so to speak.

So even if we were able to meet the global demand that we have projected in this study, that is not to say that there will not be continuing and important areas of hunger and malnutrition in many parts of the world simply because people don't have the economic means to participate in a commercial food system.

I would say that in a very important way, what we have done in this report is not so much the development of new or original methodology, nor even to make startling new long-term projections, but what we have attempted to do was to synthesize a great deal of information that is available from existing research, from existing data sources, from similar studies of the kind that we have done, to bring those into some perspective and, on our own, using substantial amounts of judgment, make projections into the future.

I want to stress—and I will stress this throughout the statement—that the report which we are referring to and the results of our assessment are not and should not be considered as projections or forecasts of what will in fact happen in the global food system. The future, in fact, remains very uncertain and unpredictable.

I think that our projections can best be viewed as a general or central tendency of future change, a general path of change, based upon trends of the past, adjusted by our best judgment of their applicability in the future and the likelihood of attaining the key assumptions which we made in conducting the analysis. If you look at our report carefully, you will see that there are in fact numerous assumptions which lace the report. We believe that those are plausible assumptions, but we cannot guarantee that they will in fact be attained.

I do want to stress that there were four major kinds of assumptions that are critical to the results of our analysis. One are the assumptions we made with respect to population and population growth rates. It is probable that we have projected growth rates which may be too high. There is some reason, some evidence, from very recent UN data, to suggest that the population growth in some developing countries is slowing more rapidly than we assumed in our report.

The second very critical assumption is that of the nature of economic growth, and here there is room for wide differences of opinion and assumption. Our assumption was that on a global basis, that economic growth would be slow, relative to the 1970's, throughout the remainder of this decade, perhaps throughout the first part of the 1990's, and that with the proper mix of policies here and abroad, it is possible that we could have strong resumption in economic growth in many parts of the world by or into the 1990's. But, in the interim, it appears to us, based upon our analysis and the analysis of others, that the prospect for the next decade or so is one of comparatively slow growth relative to that which we had in the seventies.

Another very critical set of assumptions pertains to those related to consumption patterns for food, fiber, and forest products. We are not able—and I think no one is able—to be fully on top of the kinds of changes that are occurring in consumption of food, fiber, and forest products on a global basis. We have, as best we could, attempted to include or reflect ongoing changes in diet, but we recognize that in fact those changes may be quite different than those which we have assumed depending upon income available in various countries, the distribution of income in these countries, and changes in knowledge concerning nutrition.

Finally, I want to stress another very important set of assumptions again based upon what we believe to be a plausible assessment, plausible judgments, and that was the availability and prices of U.S. production inputs. We have assumed, in our study, that supplies of commercial production inputs that are so important to modern commercial agriculture in this country—that those commercial inputs as a whole will be readily available at prices that will probably increase at about the same rate as general price level increases in the economy; that is, relatively stable real prices.

But I would point out that energy prices which are included in that set of assumptions are indeed very tenuous and potentially very volatile.

Now, given those kinds of caveats, it is clear that the reliability of our projections hinges very importantly on whether these critical kinds of assumptions are in fact realized in the future. Frankly, other analysts might have adopted different assumptions and, accordingly, reached different conclusions than we have. Obviously, in the sense of these projections being viewed as a forecast, that is quite inappropriate and in fact would be subject to very wide confidence limits if they were so used.

With respect to major conclusions and their implications, there is in our report a six-page summary of our conclusions and major implications, and I will not repeat those, but I would single out just a few that I would draw to your attention.

I think one of the very important or general conclusions that we reached was that although the U.S. agricultural and forest products sector appears to have potential capability to meet projected growth and demand to the year 2000, perhaps at real prices not much difference than those in 1979-81, and without any major breakthroughs in technology, the longer run prospects, prospects of population and economic growth, beyond 2000, let us say, are indeed much more formidable.

By 2020, production of major crops, as we saw it in the United States might need to be increased by as much as 70 to 100 percent; that is nearly doubled depending upon the particular crop. Without continued growth in productivity from technologies yielded by research, there would, in our judgment, be substantial increased pressure, perhaps inordinate pressure, on the natural resource base, increasingly serious environmental problems, and ultimately higher real costs of food, fiber, and forest products.

Given the long gestation period for many types of research, it was our judgment that a steady stream of investment will in fact be required in the course of the next two decades to meet long-term global food needs; second, the growth in demand for U.S. products that we have projected is likely to be highly unstable around the central part of development that we have projected. Although, in fact, U.S. productive capacity appears quite adequate to meet demand on average over the next decade or two, even with existing technology, it is important to continue to invest in productivity-enhancing research as a means of maintaining competitiveness in world markets; and as a consequence, the unexpected and the unpredictable vagaries of weather and public policies at home and abroad.

Third, whatever the rate of growth in productive capacity in the next decade, two decades and beyond, that growth will not be without substantial cost and hazards. Expansion by more extensive use of land and water resources may bring not only higher economic costs of resources themselves but risk of further environmental degradation through soil erosion and water pollution. But expansion of productive capacity by simply more intensive use of high technologies also could have costs and pose hazards to the environment and the food chain. A shift toward greater dependence on cash crops which we have projected and increased use of chemicals in agriculture could enhance such hazards.

Fourth, future public investments in agriculture and forestry research should be based on more than simply generating technology per se or simply multiplying product output—making two blades of grass grow where one grew before, so to speak. Emphasis, in our judgment, will be needed on the development of socially appropriate technologies that take into account not only agricultural and forest product needs that we have talked about, but also national goals concerning environmental quality, natural resource conservation, human health and nutrition and other sometimes competing social goals.

In addition to investments in the physical and the biological sciences, investments will also be needed in institutions which govern the use of technology in human development and in social science research to improve the understanding of human and institutional behavior.

One of the questions posed in your memorandum announcing these hearings was, how such projections as those that we referred to might be used in establishing research priorities. As already noted, long-term projections should not be confused with long-term forecasts. There is nothing inevitable or immutable about the outcomes of any set of projections, including our own. At best, such projections within the limits of assumptions, methods and judgment of the analyst can suggest really only general pressure points which might develop within the system in the future.

In that sense, projections may be useful to research planners in formulating long-range strategy to avoid or alleviate such pressures. For example, our projections suggest that U.S. agriculture will become increasing cash crop and export dependent in the next 20 years. Soybeans and feed grains, particularly corn, are likely to experience the most rapid rates of demand growth. That development portends expansion of cultivated acreage for those crops in Midwestern, Delta, and Southern States by withdrawal of land from pasture, double-cropping and expansion of cultivation, perhaps on marginal land. It also implies more intensive cultivation using high technology methods.

It seems to us that in combination such adjustments to meet global food needs suggests the likelihood of increased soil erosion and environmental problems in the absence of new technologies and improved management regimes. Such a possibility, it seems to me, suggests the need for research to counter such tendencies. Water seems likely to become increasingly costly in the decades ahead, with consequent economic effects on regional production patterns. Research in technology to improve water use efficiency, and institutions to encourage rational allocation of water among competing users, would seem to be of high priority for agriculture, at least in the western parts of the country.

If, as suggested in our report, export markets are likely to be the flywheel of future growth in agriculture, research to assist in identifying export market opportunities, adapting product characteristics to requirements of foreign markets, improving the efficiency of export product delivery system, and in the design of new and improved value added products could well be high priority research needs.

It is obvious, however, that research by itself may be insufficient to resolve many of the potential problems or to achieve desired public goals for agriculture, as previous discussions this morning have illustrated. Other types of policy adjustments may need to accompany research and development to encourage appropriate resource use adjustments in agriculture.

Perhaps the single most important implication of our projections for research planning is the need for continued investment in productivity-enhancing technology to meet long-term unstable and uncertain world demand, but such technology should be more compatible with the long-term public goals concerning natural resources and quality of the national environment.

Technology is seldom neutral. It does affect people and institutions in different, sometimes quite uneven ways. Thus, even if society gains from investment—that is, society as a whole gains from investment in agricultural research, as I believe research proves that it has, we should also nonetheless be concerned about how those gains are distributed, and with institutions and policies to assist the losers in the process to adjust to change induced by technology.

That is the end of my statement.

[The prepared statement of Mr. Farrell appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you very much. That is an extremely useful and provocative statement. Let me raise just a couple of questions out of many that come to mind.

You have, of course, emphasized the uncertainty involved in making these global projections which always have to include factors such as population growth, economic growth, and so on. And since I have fairly recently been looking at the development course in a couple of large, underdeveloped countries—India and China specifically, and have observed in both cases that there seems to be a strong move towards both control of population growth and the modernization of technology; the Chinese have placed the modernization of their agricultural establishment as a very high priority—I am interested in how you incorporated the possibility of rapid and successful achievement of their goals in both population and technological modernization into your projections.

Mr. **Farrell**. In the case of population, we—as I said, Mr. Chairman, we, in the project themselves, largely adopted the population projections of the World Bank, which do projections or do foresee a decline in the growth rates in both India and China, although there would still be very large absolute growth in absolute numbers of people, of course.

We did not in any formal, quantitative way, explore how—for those two countries alone—how perhaps lower population growth rates would affect the demand for food and fiber and, in turn, U.S. production. But we did in a general way look at how sensitive those kinds of projections were. And if I recall the numbers correctly, if we were to vary the population growth rates which we assumed in our study by as much as .05 points, one-half of 1 percent per year, that in any one year you are talking about a difference in the population of about 68 million people. That is a very sensitive number.

In the case of economic growth, in the case of rates of economic growth, I think the sensitivity is even greater. If, as in many developing countries, the effect of growth in India and China were to alter the composition of the diets in the same general direction as they have in other countries, favoring more meat, more poultry, more fruits and vegetables and more value-added products, I think that would have immense implications for the United States. Many of these effects I think would be quite favorable, if we are able to maintain our comparative advantage in the world in producing commodities such as feed grains and soybeans which sustain the development of a livestock economy.

We did not, in the case of either China or India, specifically play around with alternative kinds of economic growth. We did look in the global sense at variations. As I have said, the projections we have made are very sensitive to minor changes in growth—economic growth rates, up or down. I think you would have to look individually or at least region by region to see what differences there might be.

With respect to the PRC, even under the population growth rates and the economic growth rates which we assumed, our projections do indicate that the PRC is likely to gradually become a significantly larger importer of feed grains by the year 2000 than they are today; and that, as far as we are concerned, means some opportunity for the United States.

Sorry to be so long in responding.

Mr. **Brown**. Well, although India and China probably represent about half the underdeveloped population of the world today, it is likely that Africa and Latin America will be the emerging problem areas in the future.

Mr. **Farrell**. Yes, Africa represents a particularly difficult problem. Even under optimum kinds of public policies in Africa, even with substantial flows and increased flows of economic assistance, and given the population growth rates that are current and are projected, it is very, very difficult to envision Africa not becoming an increasingly difficult, serious problem with respect to food availability throughout the next two decades. That is the southern part of Africa, the Sahel and outside of South Africa itself.

There are very, very formidable problems which are going to require a long time for solution, and some very far-sighted domestic and international policies to correct.

Mr. **Brown**. The other question I wanted to raise with you has to do with your projection of optimum or desirable investments in agricultural research. Over the past generation, we have had a relatively stable level of investments in terms of real dollars, and you are suggesting what amounts to about a—in fact, better than doubling over the next decade in real terms.

That is very interesting to me, and I am sure other members of the committee, because we frequently wonder if there is any magic about the present level or whether it should be less or greater. And I am interested in knowing just what kind of analytical or other base that you used in order to come to a conclusion of that sort.

Mr. **Farrell**. The brief answer is a very general and crude one.

Mr. **Brown**. The same kind we use?

Mr. **Farrell**. I think we all do that. We all must resort to those sorts of models.

This particular projection was based upon some work done for us by two scientists at Michigan State University. The general model that they employed was to look at projected requirements, growth requirements for food and fiber, ask themselves how much we would need to stimulate productivity in order—given resources—in order to meet those projected levels of demand, very similar to our own projections, and then very subjectively with assumptions that, (a) research is going to become more costly, in part because it is likely to be more basic and capital-intensive; it is likely to require more expensives kind of equipment, more expensive kinds of facilities in addition to more talented and perhaps higher priced scientists. So the cost of research is going to go up, as well as the blend or balance of research is likely to shift generally in the direction of more costly types of research.

So that was the general methodology. And the 10 percent which is referred to here would be the amount they estimate would be required, the annual growth rate required to meet that kind of projected level of demand given these kinds of assumptions. It is a very, very broad and general indicator. I certainly won't defend or argue that it is at all precise.

Mr. **Brown**. Is it as reliable as our projections as to the amount of growth in our defense needs we are going to need over the next 10 years?

Mr. **Farrell**. I would think it probably is at least that reliable, yes.

Mr. **Brown**. Mr. Roberts, do you have any questions?

Mr. **Roberts**. I may have, Mr. Chairman.

First, I have to ask Dr. Farrell if he was present at the Curry Foundation banquet in Kansas City——

Mr. **Farrell**. No, sir. I was unable to attend that conference.

Mr. **Roberts**. Were you present—I was going to say, I must admit that I was the banquet speaker, and I read a 32-page speech, Mr. Chairman, and I was not going to inflict any more of my opinions on you had you been at the banquet. We went over some of the things that the national center has been considering.

Given that, I want to thank you for your fine statement. I especially want to thank you for observations in regard to what is ahead of us in regard to Africa. It seems to me that, unfortunately, many groups in this country somehow discover hunger about once every 2 or 3 years when the appropriate time comes around, and it is always probably too little and too late. If you ever need a 5-year plan or long-term in this regard, I think your statement is on the money.

I would point out that my colleague, Mr. Evans from Iowa, has been very active in trying to push this administration into a more activist role long term, more particularly with the needs.

I must tell you, in reading your statement I am struck by your comment on page 4 that you can't stress too strongly you are a mere mortal and the future remains uncertain and unpredictable. I am going to get on my devil's advocate hat again, and go back to my country elevator and say that—if I were visiting with my farmers, in talking about population, and say what the Resources of The Future predicts in terms of population, we have got it from the World Bank as well as in terms of economic growth.

But on consumption pattern, we are assuming a consumption pattern that will continue to be influenced by changes in income. We have some caveats and production inputs and the potential capability to meet projected growth, and demand seems to be fairly static. To the year 2000, we have growth in demand productivity capacity, the fact we are going to have to consider our farm bill with national goals concerning environmental, resource conservation, human health and nutrition and social goals that comes directly under this subcommittee's jurisdiction. They come in with forms as FIFRA and pesticide laws, and even with the Chairman, whose wisdom is equal to that of Solomon and who has great expertise and patience and understanding of these issues, and smothering people with the milk of human kindness—I don't know how we are going to get through that without a lot of controversy.

We have gone all over this. We have all the caveats and buts and can't tie anything down except the one certain is that we are going to double funds for research. That is the one certain I can pin down and tell my farmers that all of you think-tank boys come up here and say what we need for certain, for sure, is more funding, so we can be more uncertain.

Mr. Farrell. I appreciate that. But let me just add that I would attach at least as much uncertainty about the project funding levels for research that we have in this statement as I would on the other variables.

I would say, however, that that is the nature of the world we live in. If you ask any businessman, whether he is in agriculture or in production of automobiles, or whatever, about what his markets are likely to look like 5 or 10 years out, he is going to tell you, going to inject various same kind of caveats. There simply is no way of foreseeing the world, foreseeing the future. All we can do is to make some of these kinds of projections and understand the sensitivity which there is about these and make some judgments. All this cannot be reduced to formula or to a set of mathematical equations. The complexity is too great.

So we end up having to draw judgments with only very crude indicators of how the future could unfold. That is all that these are all the way through.

Mr. Roberts. I appreciate that.

Mr. Brown. Would you yield?

Mr. Roberts. I would be delighted to yield.

Mr. Brown. I just happened to be looking at page 10, which I think has the best answer to this dilemma.

When you say programs, the single most important implication is the need for continued investment in productivity-enhancing technology—this applies to all sectors of the economy——

Mr. Farrell. Right.

Mr. Brown [continuing]. It seems to me to meet long-term unstable and uncertain world demand.

Now, that is about as close to a firm statement as you could make.

Mr. Farrell. That is probably about as close as I can get.

Mr. Roberts. In other words, don't cut off our investment nose to spite our face.

Mr. Farrell. Correct.

If you look at the long-term history of agriculture, long term or even the past 30 years, in American agriculture, I think it is very clear that the investments that we have made in research, and research which has enhanced productivity, have been a very great value to society, American society as a whole, to consumers. Some farmers have ended up as the primary beneficiaries perhaps in the short run, but most farmers are not able to retain many of those gains over time.

Part of the difficulty we have in this country is in having accepted the value of increased productivity, not only in agriculture but other sectors, as the chairman points out. It seems to me that we should not cut off our nose to spite our face, so to speak.

It is true that increasing productivity in agriculture has also been a source of economic problems; that is, we have simply over-produced at some times by virtue of our productivity. But rather than saying we are too productive, I think the more reasonable way to view the problem is that we may need a different set of policies to help individuals, including farmers, to adjust to these kinds of problems, whether it is to adjust to find ways of reducing cost or find ways of hedging to deal with instability or uncertainty; and, in some cases, frankly, as happened in the past, simply moving out of agriculture.

So we may need to adjust substantially. In fact, I think we do need to adjust substantially the whole range of policies that are important in accommodating the results of increased productivity. But I think it is important that we not confuse the advantages of increased productivity with our policy deficiencies of other types.

Mr. **Roberts**. I appreciate that, and I am in your corner. And, as I said, I wore the devil's advocate's hat and worry about that base of support that was the nature of my questioning to Dr. Lund earlier. And we always have attempts on the floor of the House or in committee by those who want more of a practical result immediately, something tangible they can touch, feel and predict at least if you are a Member of Congress every 2 years.

Maybe what we need, Mr. Chairman, are more long term and smarter Congressmen as opposed to specifics in terms of agriculture research.

With that, I think I will cease.

Mr. **Brown**. I think it is clear what we do need to improve the productivity of the Congress as well as the rest of the economy.

Mr. **Farrell**. That also applies to the productivity of the economist, I might say.

Mr. **Brown**. Mr. Penny.

Mr. **Penny**. Thank you, Mr. Chairman.

Dr. Farrell, even under the best of circumstances, how far short do we fall of meeting the emerging hunger needs around this globe?

Mr. **Farrell**. In fact, there are some numbers in our full report that are largely those derived from the UNFAO. Let me see, in 1978, as I recall, there had been some reduction in the numbers of hungry people. But there were still in the order of—I should not quote the number; I need to go back and look at the document—there is somewhere in the order of 400 million, 500 million to a billion people that experienced marginally adequate nutritional diets—or less.

It is an immense problem, and these projections and this report I have referred to really don't deal with that problem at all except to note that there are going to be many millions outside this system that we are looking at.

Mr. **Penny**. Even under the best of circumstances, we are not going to meet all of that need with current production here in America, partly because we just can only produce so much and partly because we are always going to have distribution problems.

Mr. **Farrell**. Basically.

Mr. **Penny**. What emphasis should we as a nation be placing on developing the technologies and the productivity levels in developing nations?

Mr. **Farrell**. I think very high priority. If there is one——

Mr. **Penny**. Can you talk a little about what we are investing in that now compared to what you think we ought to invest?

Mr. **Farrell**. Again, I am going to be hard pressed to give you a firm estimate on that.

Mr. **Penny**. I don't want to say that we have to take away from investment for domestic production because we have to do what we can here, but I think it is realistic to assume that even under the best of circumstances we have a whole world of need that isn't being met and we have to make some investments that pay off in the developing nations, too.

Mr. **Farrell**. I think if there is one major lesson to be learned from the development experience of the past two decades, it is that trade, agricultural trade, and economic development in the developing countries go hand in hand. If you are going to improve the conditions of life in the developing countries, particularly the least developed countries, you must begin with agriculture.

Agriculture is frequently the springboard to economic growth, broader economic growth. And as economic growth has occurred in these countries—and very excellent examples of that abound particularly in Asia—dramatic changes occur in the demand and the composition of demand for food, fiber, and forest products. Those changes in composition of demand have greatly benefited American farmers. We have had substantial increases in feed grains, in soybeans and other kinds of higher valued products to many parts of Asia that have come through the development process.

So I believe it is strongly in the interest of both American agriculture and the Nation for us to have a continuing substantial program of assisting, through both technical assistance and economic assistance, developing nations of the world to stimulate their growth process. Now, it may be that in some cases and at some stage that will mean increased competition for producers of some American products; but looking longer run and looking on balance, American agriculture has much to gain.

So I believe that we should have not only enlarged—I can't tell you specifically what I would recommend, but I do think that we need to increase the rate of assistance from this country and from other countries both bilaterally and through multilateral organizations targeted to those countries wherein the growth prospects are good and where the problems of population that we referred to before are most serious.

The bottom line is that there is no way that the United States could even come close to meeting the growing total demand for food in the world. Much of that has simply got to come from increased production, indigenous to the countries where population is growing itself.

Sorry for such a long answer.

Mr. **Penny**. In another vein, I want to hear your response to the dilemma we face in trying to improve productivity while, at the same time, preserving our soil and saving our water.

Are those goals incompatible?

Mr. **Farrell**. Not necessarily and not absolutely. I think that it is possible. Let's take the case of water, for example. I think that through some changes in the allocation process—prices of water, to be more specific—that you could effect substantial savings of water in some parts of agriculture, particularly western agriculture, without it substantially affecting productivity of agriculture. That is to say, we could, with some new technologies or even with available technologies with the right price incentives, we could be more efficient without greatly reducing productivity.

Likewise, I think it is possible—although again I can't be very specific—I think it is possible that more careful application, more judicious application of pesticides and chemicals, might be possible without greatly affecting productivity. But I am reducing the risk of environmental hazards.

Now, you can—at some point you run into the limits; that is to say, we cannot have a highly productive, growing, increasingly productive agriculture without at some point running into or encountering environmental dangers. It is not a matter of absolutes; we should be concentrating on improving the tradeoff. And I have argued in my paper that I think research has a great and large role to play in that respect.

Mr. PENNY. Thank you, Dr. Farrell.

Mr. BROWN. Mr. Volkmer.

Mr. VOLKMER. I would like to first continue with the thoughts that have been discussed here concerning the future and especially for those countries which are now deficient in production for their own needs. I haven't studied nearly as much as you have, but I cannot foresee that certain areas, such as part of Africa or even China, unless there is a change in the methodology of farming, would be able to produce, sufficient for their own needs.

Do you come to the same conclusion?

Mr. FARRELL. In Africa, we certainly did. In the case of China, we are more optimistic than you may be.

Mr. VOLKMER. Even without changing their methodology?

Mr. FARRELL. No. It will require some changes in organization and perhaps in applications of particular technologies. But, generally speaking, the Chinese have achieved production records even in the face of that huge population and a fairly high population growth rate among the developing countries—China has done relatively well over the past couple decades.

I don't think—there may be some point where the productivity is going to slow without some major changes. But I am much more hopeful there than I am about Africa.

Mr. VOLKMER. Many of the presently developed nations—we have Europe, this country, Canada—how much more land is available for agricultural development that isn't presently used?

Mr. FARRELL. Relatively limited amounts. The major potential lands on a global basis are not for agriculture, are not in North America; they are in parts of the tropics, which pose other problems. Our analysis indicated that of the total output that we saw, total increases in output that we saw for food, fiber and forest products to the year 2000, only about 15 percent of it will come from increased use of land from expansion of cultivated acreage. About 85 percent of it is going to have to come from increased productivity.

Mr. VOLKMER. I noted in your paper that you provided, that you needed advances in research and funding—basically alleviating the pressure points that you can foresee with your study.

I quite agree with you. In other words, you state that the total study may not be 100 percent perfect. When we get there, we are probably going to have variables. But there are pressure points. You mentioned one.

Mr. FARRELL. Yes.

Mr. VOLKMER. Is it because you anticipate that the population consumption of meat will increase not in proportion to the amount that the grains will increase in the other nations where meat is in demand?

Mr. FARRELL. Correct.

As I indicated earlier, if the experience and patterns of the past prevail, as development occurs in the developing parts of the world, there is very likely to be a shift toward relatively more consumption of meats, poultry in particular, higher valued products of one kind or another. That translates itself into relatively more rapid growth in demand for feed grains and soybeans than it does for wheat and some other commodities in the United States.

Mr. VOLKMER. And there are more limited areas that can produce the corn?

Mr. FARRELL. Correct.

I did, also—when I commented on that previously, I did introduce a caveat that assumes that we can remain competitive in world markets, and that we should not take this for granted.

Mr. VOLKMER. In your study, did you view the possibility of using the feed grains and pasture here in this country in supplying the meat by processed freezing and shipping?

Mr. FARRELL. We only touched on that very briefly. I suppose our assumption was that the countries that are experiencing growth in demand for meat are likely going to try to meet that from internal livestock supplies, and that our principal growth will be in providing the inputs, the feeds for the livestock, rather than the meat itself.

Mr. VOLKMER. Thank you, Mr. Chairman.

I have one more. We have had testimony—and I know there is ongoing research to reduce production costs. In your opinion, is this likely to increase farm profits in the long run or simply to increase production?

Mr. FARRELL. It is hard for me to visualize ways of reducing farm costs that are not also likely to be output stimulating; and depending upon the rate of that market growth, that could put downward pressure on prices.

There is a theory or an expression which a distinguished agricultural economist has referred to as the treadmill hypothesis for agriculture. That means that you produce more to lower your costs only to find your prices falling; but once you are on the treadmill, you have to keep going. So I think it depends on how this market grows and it depends importantly on the nature of Government policies for agriculture as to whether they provide some cushions against this likelihood of increased market pressures from large supplies.

Mr. VOLKMER. Thank you, Mr. Chairman.

Mr. BROWN. Thank you, Dr. Farrell. I understood you had a luncheon appointment. I apologize for keeping you as long as we have.

Mr. Farrell. Thank you.

Mr. Brown. Our last witness this morning is Dr. Michael Phillips, Project Director in the Food and Renewable Resources section of the OTA.

Dr. Phillips, we appreciate your being here and apologize for keeping you into the noon hour. And, if we can, we would like to dispose of you in about 15 minutes.

Could you accommodate our plans there because we have to resume at 1:30?

STATEMENT OF MICHAEL J. PHILLIPS, PROJECT DIRECTOR, FOOD AND RENEWABLE RESOURCES PROGRAM, OFFICE OF TECHNOLOGY ASSESSMENT

Mr. Phillips. I certainly will.

You have my statement, and I will not bother reading it. Instead I will highlight the important areas for the subcommittee's consideration.

I certainly appreciate the invitation to be here and to represent the Office of Technology Assessment. I essentially have centered the statement around those items in your charter for these hearings in which OTA, through past and ongoing studies, can contribute.

The first area is impact of the needs assessment study. For the past year, I have had the pleasure of being invited by the joint council and its staff to be a part of the process of determining the long-term needs for food, fiber, and forest products and of determining the research required to meet the identified needs. This has been a long and arduous task for the joint council.

The council and its staff are to be commended for the document "Needs Assessment for the Food and Agricultural Sciences" that for the first time represents a broad consensus of the agricultural research community on the most urgent needs in the food and agricultural area. However, I hasten to add that the document is too general to be used as a planning document for specific research topics. Perhaps the joint council 5-year plan and the annual priorities and accomplishments reports required by the Food and Agriculture Act of 1981 will provide this specificity.

Moving on to the area of ramifications of supply and demand projections, I think I really don't have much more to add than what Dr. Farrell has very eloquently stated before the committee here today. I concur in his statement.

One of the things I would like to highlight is that one of the potentially largest payoffs in the food and agricultural export market is for high value, processed farm products. World trade in high value farm products grew fast enough over the 1970's to surpass the trade in bulk farm products that traditionally dominated world trade. The United States has been hard pressed to compete in the high value world food market.

Technologies to increase productivity in the post-harvest sector could contribute significantly to establishing the U.S. as a major competitor in this market. In fact, many of the opportunities for advances in post-harvest capability may be high tech and might be most opportune for the U.S.

However, as I testified in this subcommittee's hearings last year on agricultural research, post-harvest technology research has been neglected for many years. With the emergence of the high value export market, there is all the more reason to evaluate resources allocated to this sector.

There is certainly a great deal of interest that about the relationship between technology and farm structure as noted in the charter for these hearings. This subcommittee, along with two other subcommittees of the House Agriculture Committee and four other committees of Congress, requested OTA to conduct an assessment of emerging agricultural technologies and their relationship to public policy and changing farm structure.

OTA is now working on this assessment. The purpose of the project is to: (1) determine the most likely picture of U.S. agriculture in the year 2000 with attending impacts; (2) explain how technological advances may influence this picture; and (3) analyze public policies to mitigate possible adverse impacts or to take advantage of potential benefits. Findings from the assessment that relate directly to the 1985 farm bill will be available later this year.

As you know better than I, there are many policy questions to resolve, including: (1) Who are the beneficiaries of the present farm policies? (2) What are the impacts of less than 10 percent of all farms producing over 90 percent of the food and fiber for domestic and world markets? (3) Are basic changes needed in commodity policies? (4) What is the role of USDA and land grant universities in assisting 90 percent of the farms that produce only 10 percent of the U.S. food and fiber?

Essentially, our goal in the study is to provide policymakers with a picture of what the agricultural sector will look like as we enter the 21st Century with all the attending impacts that go with it. If policymakers are satisfied with what they see, probably little, if any, changes in public policy will be needed. If, however, they do not like what they see, they may draw upon the study's or other policy options to mitigate the negative impacts.

The last area that I would like to comment on is biotechnology initiatives. I approach this a little differently from what you probably heard in previous testimony. The concern centers around the kind of relationships which are developing, between land grant universities and the private sector in terms of conducting biotechnology research.

Traditionally, research from land-grant universities results have been readily and freely available to the public—having no private property or exclusivity rights attached to them. Historically, research, whose results were to be held in confidence or have private property rights attached to them, was frowned upon. Policy changes that have occurred over the past 15 years hold the potential for substantially changing this traditional ready and free access concept of land grant university research. Some changes have already occurred; others have the potential for occurring very rapidly.

Questions of how land grant universities might adjust to these developments have been the subject of extensive study. However, the impact on the unique nature or "social contract" of the land grant system has received little attention.

Policy changes regarding property rights in agricultural research had their origin in the enactment of the Plant Variety Protection Act of 1970. Previously, patent protection in plants was limited to asexually reproduced material—mainly orchard fruits and ornamental flowers. The Plant Variety Protection Act, amended in 1980, provides that a breeder of a new, stable, and uniform variety of sexually reproduced plants can restrain other seedsmen from reproducing and selling that variety for 17 years.

Of possibly greater significance was the 1980 landmark U.S. Supreme Court decision, *Diamond* vs. *Chakrabarty*, which held that the inventor of a new microorganism, whose invention otherwise met the legal requirements for obtaining a patent, could not be denied a patent solely because it was alive. This decision opened the door for patenting of potentially all new products of the biotechnology era.

Since the passage of the Plant Variety Protection Act and the Chakrabarty decision, private sector interest in agricultural research has mushroomed. OTA found in the study "Commercial Biotechnology: An International Analysis" that there were 61 companies pursuing applications of biotechnology in animal agriculture and 52 companies applying biotechnology to plants in 1983. The companies involved range from established agricultural chemical suppliers such as Monsanto, DuPont, Dow, Eli Lilly, and American Cyanamid to new biotechnology firms such as Genentech, Biotechnica International, MGI, and Genex.

Most of these firms have developed their own in-house research capability employing molecular biologists, biochemists, geneticists, plant breeders, and veterinarians. While the emphasis in plant and animal science in the past was that of selection and breeding for specific desired traits, now the emphasis has changed to understanding the factors that control the genetic traits and overtly changing them. Progress is already being made with growth hormones, vaccines, and herbicide-resistant varieties. Several genetically engineered products are very close to being marketed commercially.

Relationships are also developing between many of these firms and universities. For example, Monsanto has a 5-year, $23.5 million contract with Washington University under which individual research projects are conducted. At Stanford University, six corporate sponsors—General Foods, Koopers Corp. Inc., Bendix Corp., Mead Corp., and McLoren Power and Paper Co.—contributed $2.5 million to form the for-profit Engenics and the not-for-profit Center for Biotechnology Research. Michigan State University created Neogen to seek venture capital for limited partnerships to develop and market innovations arising out of research.

The formation of Neogen points up a significant problem being encountered by the universities in the biotechnology era. Neogen was formed, in part, for the purpose of retaining faculty members who are receiving offers from biotechnology companies. In Neogen, faculty members are allowed to develop their entrepreneurial talent and the associated financial rewards, while remaining at the university.

The formation of Neogen reflects the reality that biotechnology development is resulting in or has the potential to result in a substantial drain on university basic and applied research talent. If leading faculty members are not overtly hired away from universities, they may form their own companies or become consultants. The establishment of biotechnology property rights has substantially heightened scientists' interest in private sector employment opportunities. In the process, questions have arisen over who maintains the property right—the university, the private firm, or the scientist.

In the Washington University-Monsanto case, the university retains the patent rights while Monsanto has exclusive licensing rights. In Engenics, Stanford, likewise, gets the patent rights while the center and the six corporate sponsors receive the royalty-bearing licenses. Neogen will buy patent rights from Michigan State University while the inventor will get a 15 percent royalty or a stock option in Neogen.

Today, such private sector arrangements with land grant universities integrate business into the university fabric, while previously treating Government-business ties at arm's length. Questions develop over who controls the university research agenda, the allegiance of scientists to their university employer, the willingness of scientists to discuss research discoveries having a potentially patentable product associated with them, and potential favoritism shown particular companies by the university because of their research ties.

This controversy has caused the land grant Agricultural Experiment Station Committee on Policy, ESCOP, to express publicly its concerns and develop guidelines to deal with these biotechnology issues.

It should be pointed out that these issues are not new to society. The biomedical field, in particular, has been dealing with these issues since the late 1970s. R.C. Herdman, in the article "University-Industrial Relationships" in *Cancer Investigation,* discusses the controversies surrounding these issues as they relate to nonland grant or private universities in the biomedical area. These relationships between the private sector and private universities have been flourishing, and, as Herdman states, "Universities have concluded today, as they have in the past, that the industrial interface is valuable."

Indeed, Congress, by passing patent law amendments in 1980 to simplify the framework wherein not-for-profit and small businesses may engage in university-industry relationships, has indicated its intent in this area. And President Reagan, to the legally allowable extent, has extended these benefits to large businesses by executive order.

The public policy question is whether or not land grant universities chartered by Congress and publicly funded on a continuing basis by appropriations are to be considered unique. If so, these adjustments imply in part that potential basic changes in the relationships between land grant universities and the public may be forthcoming.

The advent of patent rights, exclusive licensing, and private sector investment via joint ventures and contractual arrangements in public sector research have the potential for changing the distribution of benefits from land grant research discoveries. This occurs for at least four reasons:

By exclusive licensing or transfer of patent rights to private firms, the right to use discoveries is no longer freely available—even if information on the discovery itself is freely available;

Certain individuals and/or firms are conferred the benefits of specific land grant research, to a potentially unfair advantage over others. Without such transfer of rights, the benefits are available to anyone who adapts the discovery to commercial use;

The costs of the resulting discoveries are internalized in the price of the resulting product. The price the public pays for the product also includes profits associated with the conference of the rights. Thus, it can be argued that society pays for both the cost of the research and for its benefits. Without the conference of property rights, profits are minimized by competition;

Private sector/public sector inequities are virtually assured in any granting of research property rights to any individual firm. This occurs because with a relatively small private sector investment there is access to a much broader range of current and prior research.

The argument does not, however, flow exclusively against the conference of private sector property rights by land grant universities. There are at least three main counterbalancing arguments;

With the conference of private property rights and the associated private sector investment, the quantity of research discoveries may increase. A study by Robert Evenson at Yale, for example, found a sharp acceleration in private plant breeding programs after the 1970 Plant Variety Protection Act was enacted into law. Over 1,088 patent certificates were granted by February 1, 1983;

Without land grant university involvement in private sector-funded research, it may not be able to retain the top quality scientists needed to conduct cutting-edge agricultural research. In the process, the agricultural research, extension, and teaching programs would all suffer;

Finally, patent monopoly rights may be necessary to attract the capital investment needed to translate land grant university scientific advances to commercial reality. Without such proprietary protection, new discoveries may not be able to compete for resources for development to marketable products or technologies and thus public availability.

If policymakers desire that land grant universities not confer property rights, it will be necessary to provide the level of funding whereby they can compete with nonland grant or private universities who confer such rights. That is a basic public policy decision—maybe the most basic decision since the land grant system was created over 100 years ago. Surely, establishment of proprietary patent rights, exclusive licensing, and private sector investment in land grant universities needs careful assessment and exploration of the issues by policymakers with the welfare of the universities, the scientific enterprise, and the public in mind.

Thank you for inviting me to testify, Mr. Chairman. I would be happy to try to answer any questions.

[The prepared statement of Mr. Phillips appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you very much, Dr. Phillips.

I think that this prospective you have given is a very important part of the policy issues that we are trying to grapple with, particularly in connection with next year's effort to change the farm bill as a whole.

I suspect that the trends which you have highlighted are going to continue—that is, there is going to be some loosening of the boundaries that have existed between the land-grant colleges and private sector in terms of property rights, and so on. And we will need to cope with that in some fashion.

I don't consider that to be the most difficult part of the problem. I think we may have more difficulty in dealing with this other area that you have also been involved with, which is the postharvest technology which gets us involved in a broader spectrum of the total economy, the processing and transportation and packaging and wholesaling and retailing. And all of these are part of the overall food chain. And because of the fact that they have historically been not closely related to the research base in agriculture, it is going to be more difficult to formulate a relationship which will allow us to enhance the productivity there, because of uncertainty as to who the actors ought to be and how the funding for that work will take place.

I am not sure that we are going to be able to deal with that within the present framework. I am wondering if you anticipate being able to make any suggestion on that. For example, if we feel that the opportunities for overall productivity enhancement in the food chain lie outside of the farm and its productivity problems and in some other sector, how do we relate to that? Who pays for it? How do we share the costs? How do we share the benefits?

Mr. **Phillips**. That is a very good question. It is not completely unrelated to the last area that I was discussing, because biotechnology is going to be as applicable to the postharvest sector as it is to the production sector. Some of the issues in that area are very germane.

I would just relate to you an experience that I recently had being on the program to address the National Food Processors Association Subcommittee on Agriculture, of which some of these very points were made at that time, and they expressed very much a willingness to want to begin opening up the channels of communication that for so long I think have been cut off.

I am not exactly sure what the reason for that has been, but the industry now senses that it needs to have better relations both with land grant universities and with the USDA; to give for example, direction in the kind of basic research needed for many of these productivity-enhancing technologies.

So I have maybe a little more optimism, than when we discussed this last summer, that there are some wheels in motion, and at least some dialog and communications. And one of my points to them was that they needed to make themselves known to subcommittees such as this, as well as others, that do have very much an interest in postharvest technology research and to have lines of communication that are open; they have committees on research themselves that are working with ARS and land grants; and now maybe we have a little more of a nonadversary way of approaching this than we have possibly had in the past. I had a positive response to that.

Mr. **Brown**. The optimistic side of the coin is that we are breaking down old barriers and enhancing the communications and cooperation process. But there are many other parts of the economy, sectors of the economy, which have similar problems where there is not an articulated research base which links with it a production capability in that particular sector of the economy, and we need to enhance that capability.

In a sense, agriculture is merging with the rest of the industrial base in that sense, and in the sense of commonality of problems there.

Mr. **Phillips**. That is right.

Mr. **Brown**. I want to thank you very much for your presentation, Dr. Phillips. I regret we don't have more time to explore these, but we will be calling you back for additional appearances.

Mr. **Phillips**. Thank you.

Mr. **Brown**. Thank you very much.

The subcommittee will be adjourned until 1:30 this afternoon.

[Whereupon, at 12:35 p.m., the subcommittee recessed, to reconvene at 1:30 p.m., the same day.]

AFTERNOON SESSION

Mr. **Brown**. The subcommittee will come to order.

We continue this afternoon with a series of hearings with regard to agricultural research policy and planning, and we will begin this afternoon with a panel of distinguished witnesses representing the users advisory board and the private sector. I would like to invite Dr. William Marshall, who is chairman of the users advisory board, and Dr. Jack Marvel and Dr. Will Carpenter, who have been very active in the agricultural research area and with Monsanto Chemical Co. If they would all come up to the table, I would appreciate it.

While they are doing that I would like to yield to our distinguished ranking minority member, who would like to make a comment or two.

Mr. **Roberts**. Thank you.

You have heard a great deal of testimony on the part of many witnesses about the value of agriculture research and where we are headed in regard to the kind of investment we are making on down the road.

In behalf of young people who are interested in agriculture, I would like to have the record show that we have in the hearing room many members of the Kansas Livestock Association membership who are with us. Many of these people, Mr. Chairman, are from my district and from the rest of the other four districts of our State. They are vitally interested in agriculture. They are young partners in agriculture. We have already had a good lunch, and I went over in detail some of the things we are doing here with these hearings. So I would like to welcome them to these hearings and let the record show that.

Mr. **Brown**. We are very pleased to have them.

Dr. Fontana, you are representing Dr. Marshall?

Ms. **Fontana**. Yes, sir.

Mr. **Brown**. I guess you told me that earlier this morning. We will get a card made for you in a minute.

Would you like to start, then, and you can represent the whole users advisory board.

STATEMENT OF WILLIAM E. MARSHALL, CHAIRMAN, NATIONAL AGRICULTURAL RESEARCH AND EXTENSION USERS ADVISORY BOARD, PRESENTED BY BARBARA FONTANA, EXECUTIVE SECRETARY

Ms. **Fontana**. I am here today to submit for the record testimony prepared by Dr. William Marshall, President of the Microbial Genetics Division, Pioneer Hi-Bred Seed International, of Johnson, IA, who serves as chairman of the National Agricultural Research and Extension Users Advisory Board. Dr. Marshall wishes to thank you, Chairman Brown, and members of the subcommittee for this opportunity to place before you the opinions of the private sector as expressed through the 25 members of the users advisory board, and regrets that he cannot attend today.

Dr. John Pino, another member of the users advisory board, had agreed to substitute for Dr. Marshall, but had a sudden emergency this morning. Therefore, I will briefly summarize their remarks this afternoon.

As you are aware, the users advisory board was established by the National Research and Extension Teaching Policy Act of 1977 to provide information and independent advice to the President and Congress on issues of concern to users of agricultural research and extension services. The board is proud of the accomplishments of our agricultural research institutions. Its accomplishments are heralded around the world.

There is, however, a concern that the world has changed and that these changes are placing demands on our agricultural institutions and events are moving faster than institutional and policy adjustments can be made.

The first events which we believe are having a profound effect on agricultural production and research activities are dramatic changes in population growth, food production and food trade trends which have occurred in the past 3 years, including the declining growth rate in population increase, increased food output, which are higher than population increases, trade that has been affected by the value of the U.S. dollar and interest rates and the general recession. The results are large grain surpluses and depressed prices which have enormous implications for our U.S. farmers.

The second event of concern to the UAB is the rapid pace of emerging technology. The UAB dealt with this issue and Dr. Marvel will elaborate on this with particular concern for assuring that, first, we strengthen and encourage the new directions in fundamental biological research. Secondly, that potentially new research results find their way into new agricultural technologies, and, third, that we assure that the legitimate concerns of the public are addressed.

UAB discussions have led to recommendations in two broad areas. The first challenge is to strengthen the research capability of the Agricultural Research Service and the universities. In the past few years, the agricultural research system has had extensive scrutiny. Dozens of reports and reviews have been issued on agricultural research. Briefly put, the criticisms have coalesced on several points. Overemphasis is on highly applied research at a cost to fundamental work. There has been isolation of agricultural scientists from the mainstream biological research; poor, declining quality of research in the agricultural sciences, and insufficient coordination among the various institutions engaged in agricultural research.

The second area of concern has been with input costs. These have escalated more rapidly than our yields or marketplaces. We need to understand the new picture of world agriculture to ensure that our agriculture remains competitive. How could research help achieve these goals? Supply/demand projections should certainly be used in setting priorities. The board feels there is a need for those who plan research to place greater priority on economically and environmentally sound technologies. Increasing yield alone does not ensure the soil, water, and air will not be damaged for future generations.

Between 1979 and 1982 input costs have risen 30 percent, an average for all commodities. This increase is due largely to the cost of capital as well as increased cost of petroleum. The farmer's margin has been shrinking constantly since energy and capital costs have risen.

The new biotechnology holds some promise for reducing input costs. At the present time most of the funding for biotechnology in agriculture comes from Federal agencies outside USDA. In general, fewer than 15 of our State agricultural experiment stations are able to obtain sufficient funds to work in this area. Their ability to attract these funds appears to be directly related to the number of basic scientists working within basic science departments. Since 1979 agencies outside of USDA have increased their support of the State agricultural experiment stations from $61 million in 1979 to $78 million in 1982, a 28 percent increase. At the same time USDA has increased its funding by approximately 38 percent, but on a larger, higher base. State appropriations have increased the same, approximately 28 percent.

Clearly these data indicate that Federal policymakers and legislators are supporting agricultural research in a serious way, providing stable support.

The USDA competitive grants program was established in 1978 to provide support for basic agricultural research of high quality and significance without regard to the nature of the research institution. The competitive grants program provides training opportunities to attract superior young scientists to agricultural problems. The board recommends that the competitive grants program, section 2(b) of the Act of August 4, 1965, et cetera, be restricted to basic research rather than basic applied research as the law currently reads.

In addition, there is a need to refocus and simultaneously fund the special grants program as a center of excellence program. The focus of this program should be to achieve the following objectives:

One, strengthen the scientific capacity of our State agricultural experiment stations,

Two, support institutional affiliations which stimulate rapid utilization of an emerging scientific technology to reduce agricultural input costs, and

Three, stimulate increased attention to high priority science for agriculture through competitive funding for major scientific areas.

Federal funds must stimulate affiliations of State agricultural experiment stations scientists with basic scientists in other land-grant university departments and well-known nonland grant universities. The board therefore recommends that section 2(c)(1), better known as the special grants program, be revised as follows:

The Secretary of Agriculture is authorized to make competitive grants for periods not to exceed 5 years to State agricultural experiment stations to stimulate increased attention to high priority science for agriculture that

(A) Strengthen the scientific capacity of our State agricultural experiment stations, and promote research partnerships between State agricultural experiment stations, and: One, basic science departments in non-agricultural departments of land grant universities; two, all other colleges and universities; three, other research institutions and organizations; and four, corporations or firms having a demonstrable capacity in food and agriculture science.

Thank you for the opportunity of expressing the views of the users advisory board. UAB members put in around 250 days last year on these important subjects. June 5 and 6 the UAB met in Little Rock, AR to prepare its report, which will center on world agriculture and trade and the role of biotechnology in the United States. It was the opinion of the board that there was only one position that U.S. agriculture can take, and that is to remain competitive in the face of the changing world food and agriculture situation.

[The prepared statement of Mr. Marshall appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you very much. We appreciate that emphasis, and I apologize for not remembering that you were testifying on Dr. Marshall's behalf.

I would like each of the other witnesses to present their statement before we have questions for the whole panel.

Next, Dr. Marvel.

STATEMENT OF JOHN T. MARVEL, GENERAL MANAGER, RESEARCH DIVISION, MONSANTO AGRICULTURAL PRODUCTS CO.

Mr. **Marvel**. Mr. Chairman and distinguished members of the subcommittee, I am Dr. John T. Marvel, the general manager of Monsanto Agricultural Products Co.'s Research Division. I am here sort of wearing two hats, and I would like, if I could, to give a general background in the biotechnology area and then turn the microphone over to Dr. Carpenter, manager of Monsanto Agricultural Products Technology Division, who can give you a perspective in the regulatory area in greater depth. And then if I could take an extra 5 minutes or so after that to summarize the philosophic points of the users advisory board as it relates to biotechnology regulation.

Mr. **Brown**. Certainly.

Mr. **Marvel**. I first state we appreciate this opportunity to state our views on biotechnology and biotechnology regulation from an industry perspective. I will lay the foundation for the importance of biotechnology to the future of agriculture and the world food supply. Integral to this future are basic research, regulation of the products of that research, and intellectual property rights.

I won't go through all the statistics, as I know you are well aware of them and they are in the draft testimony. But agriculture is the largest of the world's industries. It is certainly the largest U.S. industry, and I can't overemphasize its importance. Not only from its productivity and what it has been able to do, but the fact that it represents nearly a quarter of the jobs in this country as well as a quarter of the gross national product. And if we do things that hamper the work competitiveness of our agricultural output, we potentially risk very large employment problems in many other segments of the agricultural industry.

I think you have probably heard from various preceeding testimony that there are a number of outstanding biotechnology efforts going on around the world. There are certainly major efforts underway in the plant biotechnologies in Australia and in Japan and in Europe; specifically, England, and France and Germany. The world is paying attention to this. It will be done, and it will be a world competitive situation.

Mr. **Brown**. If I may interrupt you briefly. We had testimony yesterday from someone who had participated in the Australian work, and we asked them to supply additional information with regard to that to the subcommittee. We are a little surprised at finding other countries in the world that are at least up with us, and maybe ahead of us in some areas.

Mr. **Marvel**. Well, I will be glad to give any information I can on that if you would like to have it.

Mr. **Brown**. Thank you.

Mr. **Marvel**. I think we can safely say modern agriculture can be characterized by advances in plant breeding and the development of improved farm implements, fertilizers, and pesticides. Genetically superior plants, derived from current crop improvement programs, require a high level of crop management. This crop management consists, in part, of an increasing need for large amounts of nitrogen fertilizers, herbicides and other pesticides, all of which have various disadvantages. For example, intensive inbreeding and narrowing of the genetic pool of widely cultivated crops, such as corn, are causing increased concern about susceptibility of these major crops to catastrophic disease and pest outbreaks.

Biotechnology is a tool that can be used by scientists to ensure that man's food supplies are met. Biotechnology, in a general sense, is the use of living organisms or their components in agricultural, pharmaceutical, food, chemical and other industrial processes for the development of a product. Biotechnology is a process, not a product. The critical importance of this maturing technology cannot be over-emphasized.

Advances in biotechnology which will improve crop productivity fall into two areas: Genetically engineered plants and genetically engineered microbial pesticides. While genetic engineering will ultimately result in plants with enhanced fertilizer use efficiency, enhanced protein and seed oil production, and improved breadmaking qualities, much of the earlier progress will come from the transfer of simpler, single gene traits, such as disease, insect and herbicide resistance, since such transfers are now technically feasible.

Significant effort is being devoted to the identification and isolation of herbicide resistant genes which can be inserted into plants to make them less sensitive to nonselective herbicides. There are three different routes by which a plant can defend itself against the action of a herbicide: Preventing uptake of the toxin, detoxifying the herbicide by degrading it, and modifying the target site of the herbicide.

Efforts are also being devoted to identify and transfer microbial genes coding for antibiotic production to plants so that plants can produce their own fungicides and insecticides. Such developments could dramatically impact the environment by elimination of many current control measures.

However, the major impediment to the advancement of biotechnology in agriculture and food production is the lack of knowledge about gene organization and regulation in higher organisms such as plants. There is a large gap in the understanding of the basic plant biochemical mechanisms which regulate growth, development and reproduction. Identification and isolation of agriculturally important genes for transfer into crop species are of paramount interest and importance.

Once the genes necessary for valuable plant traits have been identified, practical applications will follow rapidly. The necessary basic knowledge in biotechnology will come only by an adequately funded, long range and directed commitment by the Federal Government in basic agricultural research.

The pharmaceutical industry is an example of what can be accomplished with biotechnology in a relatively short time when there is an adequate base of fundamental knowledge. A partial list of products produced by biotechnology which are under clinical or animal test include: 12-plus subtypes of interferon, human growth hormone, human calcitonin, human serum albumin, monoclonal antibodies, porcine growth hormone, bovine growth hormone, foot and mouth disease vaccine, and bovine leukocyte interferon. Human insulin produced by biotechnology has already been cleared by the Food and Drug Administration for use. These examples clearly show what can be accomplished when an adequate base of knowledge exists.

In parallel with efforts directed towards the genetic engineering of plants are efforts to genetically engineer microorganisms that live in close association with crop plants. Genetic engineering of these associative microbes may lead to more effective and more environmentally desirable pesticides to protect the large percentage of the world's food supply that is lost each year to insects and disease.

Another important area of biotechnology application which I will address is animal production. Animals are a source of protein and other products useful to mankind. Several different approaches to increasing this source of protein are being explored using biotechnology. The production of porcine and bovine growth hormones using genetically engineered microbes is one area under development.

Another area under investigation is amino acid production since higher animals cannot produce all the amino acids they need for protein synthesis. If one of the essential amino acids is missing, protein synthesis will stop, and the other amino acids will not be utilized. The limiting amino acid in a particular case is a function of the animal and its feed. Various deficiencies of seeds in certain amino acids do not allow either cereal grains or legumes to provide a balanced diet. Supplementation of the limiting amino acids from other sources is necessary. The major source of animal feed in the United States is soybean meal. The limiting amino acid in this feed is lysine for swine and methionine for poultry. Other limiting amino acids include tryptophan and threonine. One probable use of recombinant DNA techniques will be to increase the yields and lower the cost of production of these limiting building blocks.

Modern animal husbandry practice utilizes intensive management techniques. Close confinement of animals brought about by these practices aggravates management-induced disease in animals. Frequently the disease spreads so quickly that antibiotics cannot be administered. For this reason, genetically engineered vaccines are being developed to prevent management-induced diseases, such as neonatal scours in pigs and calves. Other animal viral vaccines which are in testing include avian leukemia virus, foot and mouth disease, virus avial myeloblastosis virus, and Rous sarcome virus.

Mr. Chairman, I have covered many exciting areas of agricultural potential in biotechnology which will make a strong and positive influence on all mankind. The pharmaceutical industry already has products that are in the marketplace, in clinical trials or in animal testing. The outlook for agricultural biotechnology applications is even more exciting. The potential of increasing the world food supply while decreasing inputs and environmental losses will be a boon for this country's agriculture and for the world.

However, many obstacles must be overcome before the full potential of biotechnology can be realized. The lack of fundamental knowledge of genetics, biochemistry, and physiology in plants and higher organisms must be remedied before rapid progress can be made. The current unstable regulatory climate is impeding progress and must be stabilized.

Finally, the development of biotechnology applications requires an enormous input of financial and human resources. This investment must be protected with stronger and uniform intellectual property rights. Without this protection the willingness for industry to invest in biotechnology development will be hampered.

It is a somewhat more difficult situation than normal—Dr. Carpenter may speak of this, also—because of the gigantic difference in sizes of firms that are involved in this issue, so it makes it a much more complicated regulatory problem from a finance point of view, as well as public information, than perhaps we have looked at before.

Thank you.

[The prepared statement of Mr. Marvel appears at the conclusion of the hearing.]

Mr. BROWN. Just a comment, I seem to recall from the not too distant past when the Supreme Court ruled in the *Chakrabarty* decision, it did indicate a need to establish some rules for the protection of intellectual property rights in living organisms, although it indicated that the existing patent laws were applicable until some modification was made to the laws which seems to bear out what you are saying.

Mr. MARVEL. Well, there are three areas of property rights. I will make a comment on the patent issue. I think the patent issues in this area are probably not going to become real clear for another 5 or 6 years, but I also think the science will progress fairly rapidly at that time and you will be in a situation where the current patent laws are more applicable to what the scientists are going to see 5 years from today than it is today.

But the patent rights are certainly major issues. International trade policies as they affect appropriate territory rights in other countries that are reciprocal and of course data release, again the old bugaboo, is a problem from the point of view of piracy.

Did you want Dr. Carpenter to proceed?

Mr. BROWN. You may proceed with your testimony.

STATEMENT OF WILL D. CARPENTER, GENERAL MANAGER, TECHNOLOGY, MONSANTO AGRICULTURAL PRODUCTS CO.

Mr. CARPENTER. Mr. Chairman, distinguished members of the subcommittee, I am Dr. Will D. Carpenter. As Dr. Marvel indicated, I am general manager of technology for Monsanto Agricultural Products Co. and have been involved in research and development in agriculture for over 25 years. During this period of time, I have worked closely with USDA and land-grant university professionals, and served with them on numerous committees and organizations.

Monsanto's position on the regulation of the products of biotechnology can be summarized very briefly. My company believes the regulations should be effective, scientifically based and implemented under existing laws. And, we believe strongly that steps should be taken starting now to begin this process.

Our views are based on our knowledge of this science and on its potential. As Dr. Marvel has indicated, biotechnology and the products which will flow from it offer the possibility of treatments for previously intractable diseases; opportunities for dramatic increases in food and fiber production; and, significant savings of natural resources. Biotechnology is the most exciting science of our time.

We believe in the science, and we believe that it must be regulated. First, because the public and the environment must be protected. Potential risks from biotechnology are manageable and regulations are needed in that management. Second, and equally important, the public must perceive that they and the environment are being protected.

They must have confidence that work is being done by responsible scientists with the approval of responsible regulators. That way, the public will be able to reap the benefits of new scientific breakthroughs without unnecessary delays.

Monsanto also has firmly held views on how the regulatory structure should be formed. First, we believe the Federal laws already in place, and the agencies designated to enforce those laws, are sufficient to handle this emerging science. New legislation is unnecessary, particularly if the agencies exercise existing authority. In addition, new laws are unlikely to be more effective than the laws already in place.

Second, within the framework of existing laws, there must be greater consideration given to the protection of intellectual property rights such as trade secrets and patents. Biotechnology, like all science, is an intellectural activity. Expertise builds over time, at great expense.

Protecting this intellectual property will provide incentives for more companies to engage in new research. When that happens, the public benefits through new and better products.

Third, there also must be consideration given to methods which allow smaller entrepreneurial companies to meet regulations. These companies represent a large part of the emerging biotechnology industry. They are rich in science, not so rich in other resources. Their survival must not be jeopardized by overly restrictive regulations.

And, finally, the agencies must build up their expertise quickly. Regulations should be drafted as soon as possible, but those regulations must be based on a firm knowledge of biotechnology in all its manifestations. We support the added funds it will take to build this expert staff, and we urge that the agencies get on with the job.

In developing that expertise, it would be helpful to name panels of expert scientists and other participants to advise the various agencies within their existing authority. People on the panel should be experts in their fields, but largely disinterested in commercial applications of science. That will increase credibility and protect trade secrets. For instance, the EPA, under FIFRA, has the authority to create such a panel. The people who compose the RAC Committee are one source of scientists to be considered.

The Federal Government and the biotechnology industry must show the nation that they will exert responsible leadership. We must avoid the patchwork quilt of State and local laws that can hamstring research and postpone commercialization. To avoid that, firm fair regulations are needed. And, they are needed soon. Products from biotechnology are being developed now. Regulations must be in place to deal with them. We can't afford to wait.

Stringent scientifically based regulations will allow the young biotechnology industry to bring its products to the public in a responsible way. Society, in turn, will benefit from this tremendously promising technological tool. Writing regulations, building expertise and establishing credibility are tough goals. But the effective regulation of biotechnology is a rare opportunity for industry and Government to work together early and to do it right the first time. We must achieve that.

Thank you.

Mr. **Brown**. Thank you, Dr. Carpenter.

You wanted to make an additional statement?

Mr. **Marvel**. Yes, if I could take off my Monsanto hat and put on the users advisory board hat, I can summarize the deliberations we have been in over the last 2 days in terms of our own feelings about biotechnology regulation.

They are not grossly different, but there are some areas which I think the members would like to express in that sense. This is simply an overview and we will submit the precise testimony as soon as we can polish it up.

Biotechnology is perhaps the most exciting field in science today. The potential benefits to society are enormous and far reaching. The pharmaceutical industry has developed genetically engineered microorganisms for the production of human insulin, human growth hormones, and interferons to name a few.

The prospects for the agricultural industry are even greater. The production of products such as animal growth hormones and less expensive sources for amino acids for feed supplements and additives will improve the production efficiency and quality of meat that is available at a lower cost.

The development of genetically improved crops that would increase temperature tolerance, drought resistance, disease resistance, pest resistance, salt tolerance, herbicide resistance, and produce higher yields would be of major benefit to mankind in all areas of the world. The potential benefits of these scientific efforts are virtually unlimited, however, there are certain concerns that must be considered.

This boon to the world could be greatly hampered if the regulation of this emerging industry is not done effectively, scientifically and in the public interest. The industry should be regulated. This will afford protection of both the public confidence and trust in the industry.

Adequate Federal laws are already in place to accomplish this. The agencies designated by these laws, for example EPA, FDA, USDA, OSHA, et cetera, are sufficient and will be able to handle this evolving science except for some areas that have not yet been clearly defined and specific regulatory authority assigned and accepted.

Agencies that have regulatory authority for biotechnology products can refine guidelines and regulations for biotechnology most expeditiously and credibly by naming panels of recognized experts that can represent all concerns that is, scientists, lawyers, environmentalists, theologians, and representatives from the public and private sector. The panel members should not be directly involved in commercial applications of biotechnology. That will increase credibility and serve to protect industrial trade secrets.

As a corollary to the development of effective regulation, greater consideration to the protection of intellectual property rights for example, trade secrets and patents must be given. Expertise in science, including biotechnology, builds over time. Expense involved in building this expertise is great.

Proper and effective protection of this developed intellectual property will provide necessary incentives for more companies to engage in new research. This will ultimately benefit society in new and better products. Smaller entrpreneurial companies represent a large fraction of the emerging biotechnology industry. Though they are rich in scientific expertise, they are often not as well endowed with other resources.

The survival of these important biotechnology businesses must not be jeopardized by loss of their intellectual property rights. Several concerns about biotechnology have been expressed by various people and must be addressed in an objective, responsible way, including the types of products that can be developed, their benefits, potential hazards to people or the environment, and the extent of research that should be done in modifying genetic codes.

We therefore recommend the establishment of a temporary National Biotechnology Coordinating Commission with the following functions:

One, define interagency lines of jurisdiction and authority for guidelines and regulations for research, development, and product registration for current and anticipated needs;

Two, provide an information clearing function to direct questions or jurisdictional queries to the appropriate agency;

Three, insure that each regulatory agency or some other existing agency: (*a*) establish a continuous dialog and consultation with public and private sectors, to assure to the extent possible, progress of biotechnological sciences and protection of the public, (*b*) monitor international research development, regulatory activities, developing problems and new opportunities, and (*c*) provide guidance and encouragement for future development of scientific expertise and product development within appropriate bounds of public safety.

Four, at the termination of the Commission, it should provide a final document outlining a procedure for resolving future unanticipated issues relating to more than one agency. The Commission should be independent, with the Director appointed by the President and confirmed by the Senate.

It should include responsible representatives from FDA, EPA, USDA, OSHA, the scientific community and the public. It should have only a 1 year life to insure that current organizational and functional problems are solved without building a new permanent layer of regulatory activities.

The recent appointment of Dr. Keyworth's group to a function like this may in time or in part solve this problem. The other issue that the board thought about and is thinking through is that basically in the board's point of view there are three places to watch. One is the research functions, the other is the development function and the third one is commercialization activities that go on.

It was the boards unanimous feeling that the RAC Committee has done an adequate and good job of regulating the research part of the function. And we don't see any reason to change that other than if there is a statutory problem with it for some reason and we would recommend that to establish the proper guidelines and rules for people when they move out of the laboratory, I define research as anything done in the laboratory.

When we move outside the laboratory it becomes a development or commercial phase, and that should be determined by these expert panels in conjunction with a specific regulatory agency with authority over that area. We felt that that would probably provide the most expeditious way to try to establish the proper regulations and still operate in the areas of expertise that these people should be in.

Mr. **Brown**. We would be very pleased to have you submit the final polished version of the board's deliberations at such time as is convenient for you, Dr. Marvel.

I did note that you recommend that the advisory committee setup include a theologian. You want to elaborate on that a little bit.

Mr. **Marvel**. Well, certain sectors of the nation have apparently very deep-seated roots in this area and I don't think, if I could be frank, that certain elements of it will ever be convinced this is an acceptable activity, but I do believe that it is very important for those people to be represented—not those specific people, but the religious community if they have those concerns to be represented.

Now, we are suggesting there is a need for the public in general to be represented in a proper way, in all areas of concern. We think it is very important that this sort of thing not be in any way viewed as some sort of dark box. The public must be as satisfied as is humanly possible. Both the credibility of the private sector and the agency should be kept as high as it possibly can be.

Mr. **Brown**. Thank you. Mr. Roberts.

Mr. **Roberts**. Mr. Chairman, I appreciate this opportunity. I want to thank the witnesses for their very fine statements. Dr. Fontana, when you were reading the statement on behalf of Dr. Marshall on page 3, you made a suggestion that the joint council should probably have a special study to determine the most significant farm input cost that can be resolved by research and extension.

I wonder if you could go on further with that suggestion. I am very much interested in the cost of production problems. We have a cost of production board now within the USDA which is working very diligently to determine the cost of production figures in the most up to date fashion and those are in turn used by the committee to establish loan rates and target prices and programs support.

I noted that you also said that there is a need for the joint council to place greater priority on environmentally desirable technology to assure the consumer that the soil, water, and air will not be damaged for future generations. I would add only that the only way we have been able to keep our head above water and some respect is to increase the yield.

That has been the only way we have been able to, pardon the expression, beat the farm program and beat the interest rate and beat the embargoes and I guess beat everything else out in our country in order to stay viable. Would you comment on that? What kind of cost of production are we talking about here? I asked this same question of a witness yesterday.

Mr. **Marvel**. I have to try to answer for Barbara because she is not supposed to answer in the respect as a member of the board. So if I get off track, I hope she will kick me.

But I can at least explain some of that, I think. I think there is a discussion among the board particularly as we go through discussions particularly with producers on the board, how do you calculate your cost of production—and their various methods to do this, but it is a difficult thing to nail down.

First of all, any farmers' cost of production is different than any others because they all operate absolutely differently. But what we are saying is can we get some kind of tracking mechanism, say on what farmers' inputs tend to be in Kansas and what they tend to be here and there and various areas?

As a comparative basis and also as a tracking basis to measure ourselves, are the costs going up real fast or going down real fast? Can we get some kind of agreed upon system to do this with?

Mr. **Roberts**. You will never get any individual Congressman who is privileged to represent a farm district to admit the cost of production for any crop went down.

Mr. **Marvel**. I think that is unfortunately probably true.

Mr. **Roberts**. I don't think you will ever really get them pinned down on what the cost of production is, at least in terms of your input here. I wish you well.

Let me say that both you, Dr. Marvel, and Dr. Carpenter's comments pretty well summarized on page 2 about the regulatory structure in behalf of the Monsanto Co. Can you briefly tell me why does Monsanto have the position that you just proposed?

Mr. **Carpenter**. Mr. Congressman, the amount of resources that a company like Monsanto must commit to on a long-term basis, the leadtime that is necessary for the research and the development and the commercialization just demand a reasonably predictable future, nothing guaranteed but we must think we can predict the future in which we are going to operate.

One way that we can assure that we have got a shot at a reasonably predictable future is to have a predictable regulatory environment. If we start with good regulations, we have a better opportunity to avoid bad regulations or unpredictable regulations. And that is kind of the same thing and if you want to put it in a negative sense, the prospect of bad regulations, overregulation, and/or non-science-based regulation because of over reaction from inadequate regulations now, would be sufficient, I think, to have a substantial dampening effect on the biotechnology arena.

In other words, if we know that we have an opportunity to succeed, no guarantees, we are willing to ante up our resource. If we think we are going to be working in an environment in which the regulations will almost preclude breaking out new products, we will have to hunt in another area.

Mr. **Roberts**. Is your position generally shared by the other companies?

Mr. **Carpenter**. A number of other companies that are active in the area of biotechnology, I know, share our views. I can't speak for them. I think there are some other companies that haven't quite gotten up to the same place we have in our line of thinking.

I think as they think through the issue, they will. I might say that the new entrepreneurial biotechnology firms that are making the contributions that Dr. Marvel and I have both stressed, are composed of primarily two types of people, entrepreneurs and academic scientists who are entering the public arena for the first time and are not aware of the past 20 years' history that has shaped the regulatory environment.

And I think they have yet to discover in some cases the fact that good regulation is the best atmosphere to work under as opposed to no regulation which is not going to happen and that won't happen.

Mr. **Roberts**. What environmental laws impact your copy?

Mr. **Carpenter**. We are working on two products now that we hope we have started on the path to commercialization. One of them will be regulated. We are certain as can be, we will be regulated by the Food and Drug Act. Another one that we would hope to commercialize . . . we are fully prepared to be regulated under FIFRA as we bring that product to commercialization.

Mr. **Roberts**. I won't predict the future of that. I can't predict the future of FIFRA. I have no further questions.

Mr. **Brown**. Mr. Volkmer.

Mr. **Volkmer**. Yes, I want to thank Dr. Carpenter and Dr. Marvel for being here today. It is good to see you again. Tell us how much Monsanto is doing as far as basic research with the universities in the biotechnical area. We have good in-house.

Mr. **Marvel**. In dollars, for example?

Mr. **Volkmer**. I would say in percentage to what you are doing.

Mr. **Marvel**. I don't know if I can give you an absolute number I could swear by. I would say the number is probably, if you include the Washington University efforts and efforts that are related to the Harvard project. We have a large grant with Rockefeller University. I would say it is in the 10- to 20-percent range of our total research effort.

Mr. **Carpenter**. That is correct. It would start approaching $100 million, certainly well above 50 annually.

Mr. **Volkmer**. In the area, as far as sharing of the research information, is that basically appropriate territory as far as that information is concerned.

Mr. **Marvel**. There is a document, there is an article also in Science that tries to explain the basis of the relationship, for example, with Washington University, but in a simplistic way, yes, the information is shared quite a lot with the scientists because they are doing fairly joint proposals.

Monsanto has certain rights and Washington University gets certain payments for those rights and certain of them, because we don't know what the future of them will be, are to be negotiated when we can see what it is going to be. I would say, to be fair, to characterize the relationship thus far as being pretty productive and that it seems to work very well.

So I would say our summary would be we are pretty pleased with it at the present time and I think Washington University would tell you the same thing.

Mr. **Volkmer**. You elaborated in your statement approximately, in the areas in which you could look forward to trying to solve some of the problems, in plant disease, animal disease, herbicides, all down the line. Which of these areas would you say looks the most promising at the present time by the year 2000.

Mr. **Marvel**. Well, when I talked maybe last year about this subject, I would have said the year 2000. Now I might not have gone that far. So many things have happened to us that sped up progress I would now probably tell you most of those things will occur before the year 2000. I think that the fastest products being developed frequently relate to agriculture. In the plant sciences I could foresee the possibility and I want to emphasize that because many of the experiments that we now think we can do still haven't been done so far by anyone.

So it is like trying to predict a black box here, but the microbial area has a lot of potential to move very quickly. That is an area that is very dependent on good regulatory rules and good ways to see that because that is an area where people are concerned.

We think that we have a program and we hope to go and discuss this with the EPA shortly in a responsible way about how we have developed that; why we know the technology better; how we know the lifetime in the soil for it and try to establish the fact that this can be done. But frankly, we don't want people being hysterical. We want to be able to explain it. That could go quite fast.

Mr. **Volkmer**. Now, Dr. Carpenter, you referred, I believe, to the area of the necessity to have the agencies sufficiently staffed with expert people sufficient enough to be able to write the regulation and do the regulating. Do you find that satisfaction at the present time looking into the future?

Mr. **Carpenter**. They have the organizational structure in which to implement. However, particularly when it comes to the microbial pesticides, the same tests that should be run to determine whether a chemical is safe or not may or may not be useful to determine whether a modified microbe to provide an insect control would be useful.

Now, at that point in time the agency will need to have one person on their staff or access to expertise that would say here is the test that you, Monsanto, must run in order to meet our regulatory requirements. And I think that agencies are well aware of the need. I think they are working toward accumulating those skills, but I would have to say right now they have a way to go before they could write the applicable guidelines or regulations to do so.

I think, however, that they are getting up to speed with the sense of urgency at least certainly in the one that I am responsible for. In relation to FIFRA, I sense that the OPP is well aware and doing their utmost in getting up to speed on that.

Mr. **Volkmer**. In this regard, how far are we along in the biotechnology field where not only Monsanto, but other companies may be going to the agencies for processing for approval for regulation? Next year? This year? Four years?

Mr. **Carpenter**. I think under FIFRA there is a section 5 called Experimental Use Permits, in which you engage in experimental testing and then there is a section under FIFRA prior to that. I think Monsanto will be going to EPA within the next few months to discuss procedures and requirements.

I am afraid I can't speak to my competitors' status at this point in time, but I would daresay they are probably in the same boat. Within the next 12 months, I think you will see a number of people going for experimental use permits under section 5 of FIFRA.

Mr. **Marvel**. I agree with that.

Mr. **Volkmer**. How far along that line are we for commercialization of any type? Hoped-for commercialization.

Mr. **Marvel**. Again it depends a little bit on what happens when you see it outside, assuming we can get it outside legally and properly. If the right things happen that we hope to in terms of technology, degradation, effectiveness, then it will depend to some extent, I think, more on how long the regulation process takes more than the technical.

We could be ready pretty fast if it works.

Mr. Carpenter. If you look at the history of commercializing a pesticide under FIFRA, more traditional chemical pesticides and the parallels of such, I think, you could say that from the time you apply for your first experimental permit under section 5, you are probably 4 to 6 years away from commercialization.

Mr. Volkmer. That is on a regulatory process.

Mr. Carpenter. That's right.

Mr. Volkmer. That brings me right back to the recommendation you brought up in the rough draft and that is, on the commission and you want the standby law.

Mr. Marvel. I think, as I said, maybe Keyworth's group is a perfectly good alternative to that. I won't necessarily say no to that. I also don't want to create a bureaucratic stopping point. So I really want a clearinghouse for decision points that is aimed at speeding it up, not slowing it down.

Mr. Volkmer. You want a commission to review the process within the regulatory.

Mr. Marvel. In case there are any spats, you get the feeling—we do from various people, including the Congress, that people aren't totally sure of exactly what the jurisdictional lines are and there would be—it seems to us at least—there would be very many benefits if somebody could fairly quickly have authority to say OK, that belongs here or belongs here and get that done and let them get on with the process.

Mr. Volkmer. You want it done by the Congress. We haven't started on it yet.

Mr. Marvel. I understand.

Mr. Volkmer. If we don't do it this year that means next year.

Mr. Marvel. I think we would probably be prudent to let you give us some advice on what your best judgment about that would be and most effective.

Mr. Volkmer. Thank you, Mr. Chairman. I will let the chairman take that one over.

Mr. Brown. Dr. Marvel, you made reference in your statement that advances in biotechnology which will improve crop productivity falls into two areas: genetically engineered plants and genetically engineered microbial pesticides.

Are you sure that is broad enough to include all of the possibilities for improving agricultural productivity?

Mr. Marvel. Maybe not, in one sense I probably shouldn't just say microbial pesticide, because microbial sources may be a wide source of certain sorts of genes that may prove very useful. That is still to be determined. So in that sense, I would certainly say it is probable.

Mr. Brown. What about the possibility of doing something on nitrogen fixation or enhancing photosynthesis? Is that in the category of genetically engineered plants?

Mr. Marvel. Yes, sir, yes, there is no question of the cross over between the two. Now I may have also ignored a couple of——

Mr. **Brown**. Nitrogen fixation comes from microbes, doesn't it? You can put microbial genes into the plants for them to fix their own nitrogen.

Mr. **Marvel**. Yes, sir, in the case of this also we may be ignoring some other potential use, although I am not sure conceptually if they would fit as there may be ways to produce desirable animal characteristics in plants or plants characteristics in animals.

To that extent I guess you should include potentially anything that you can get genes out of as a potentially useful source.

Mr. **Carpenter**. If I may make a remark to followup on Dr. Marvel, the rapidly changing science, the knowledge that is growing by leaps and bounds, almost dictates that if we try to regulate this by new legislation, we will be forever playing catch up. This industry and the products following from that industry are going to take a great deal of creativity on the part of everyone in order that regulations stay up with the science.

And we just aren't going to be able to predict—even Dr. Marvel and I, if we are away from home for 2 weeks we are almost behind on what is happening and I would hate to see that.

Mr. **Marvel**. To add to that, I want to emphasize that we are doing experiments. Many people are doing experiments that have never been done before and in most cases when you do this kind of thing in science you get a pretty high failure rate.

What is astounding to us is that in the last year they seem to work all the time and sometimes the first time through. The first time we got a microbial insect toxin which by the way isn't very toxic to people. It has been tested and put in the microbe. We got it in there and had the bug eat the microbe. The bug died. We were flabbergasted.

That is an example of the sort of thing Will is talking about.

Mr. **Brown**. There is a somewhat similar situation in other rapidly developing technological areas such as computers, telecommunications and so on.

Mr. **Marvel**. That's correct.

Mr. **Brown**. We are completely unable to keep up with the regulatory needs for computers and telecommunications through legislative changes, but FCC and the courts are preempting the field here and probably rightfully so because I doubt if the Congress could enact legislation which would adequately encompass the rapidly changing activities that are taking place here and in the biotechnology area.

It seems to be very similar in many aspects. I have in the back of my mind a recollection of reading something. I may have read it in Science magazine about some bugs laying eggs on plants and it secretes some sort of material that repels other bugs, including bugs of the same species and they were trying to figure out if they could isolate exactly what it is that it secretes so they could use that as a pesticide agent, I guess.

Is that an example of what is happening? This isn't genetic manipulation as much as it is biology.

Mr. **Marvel**. Well, maybe two sides. I don't believe they know what this material is and it may depend on what it is and whether one gene is needed to make it or a series of genes, and if those series of genes happens to be next to each other so they are easy to work with, but it is an example of a potential way you can use genetic engineering in that sense once you see what that link is.

Mr. **CARPENTER**. You could visualize three possible commercial outcomes. First, we merely identify the chemical, synthesize the chemical itself used in a convential way. Second, if you could move that genetic material into a microbe, spray the plants with the microbial pesticide or, not thirdly, in conceivably, you might introduce that genetic character into a cotton plant, into a corn plant and have the plant itself do it.

So, the vistas are just about as broad as you would want to go.

Mr. **BROWN**. Dr. Marvel, there is one question which was raised in Dr. Marshall's statement. He made a recommendation on page 6 that the competitive grants program ought to be restricted to basic research. Have you thought through carefully all of the problems that would be created if you tried to do that in terms of how you would distinguish between basic and applied research. It is a problem I have never yet solved.

Mr. **MARVEL**. We did in fact in the Board discuss that at some length and you are undoubtedly correct, I think that what we finally decided and it is not easy to tell from that statement, is that if proper peer review panels are formed like the NIH, NSF type models, then the risk of that would probably be fairly small although I am sure it would be there.

I think that there would be a vast argument amongst the agricultural and other communities about what constituted that, so you are probably——

Mr. **BROWN**. You really want to be protected against what the chairman of the Appropriations Committee did yesterday, in which he took a lot of that special research and put it over in the competitive grants and it really is best done in the experiment station setting.

Mr. **MARVEL**. Yes, sir.

Mr. **BROWN**. And not on a competitive grant basis.

Mr. **MARVEL**. That would be our opinion, yes.

Mr. **BROWN**. I have no further questions at this time. I very much appreciate your testimony and we will be back to you, I'm sure.

Our next panel is Dr. Lawrence Busch, University of Kentucky; Dr. William B. Lacy, also from the University of Kentucky—if you two will come forward, your particular focus seems to be in the area of sociology and the various problems of farm structure and the public benefits of biotechnology.

I am very pleased that you are here, frankly, we do not give sufficient attention to the research needed in your particular areas and the contribution that sociology can make, I think, has not been fully utilized. So would you proceed with your statement? You can begin, Dr. Busch, and the full text of your statement will appear in the record.

STATEMENT OF LAWRENCE BUSCH, PROFESSOR OF SOCIOLOGY AND COCHAIR, COMMITTEE FOR AGRICULTURAL RESEARCH POLICY, UNIVERSITY OF KENTUCKY

Mr. Busch. Thank you, Mr. Chairman. I appreciate the opportunity to present my view on planning and policy issues facing U.S. public sector agricultural research. I will focus upon the issue of agricultural research and development and farm size, and two, the socioeconomic impact of new plant biotechnologies.

First, with regard to the impact of agricultural research on farm concentration, the basis of this part of my statement derives primarily from a National Science Foundation, Program on Science Resource Studies, grant to examine statistically the effect of public agricultural research on the concentration of farm production from 1915–73.

The competition of the marketplace, so well described by Adam Smith, created a powerful demand for new technologies. Simply put, in a competitive market, profits tend to decline toward zero. Therefore, the farmer who wishes to increase his profit is compelled to reduce costs. Cost reduction may be accomplished through either improved management of resources and labor, or technical innovation. This creates an enormous demand for new technology.

Over time, the continuous infusion of new technology into a competitive market is likely to have a number of effects on that market. First, it is likely that early adopters of new technology will be able to significantly increase their market share. Conversely, late adopters are likely to be driven out of the market by their failure to realize a satisfactory rate of return on investment.

A second consequence of the treadmill is a vast increase in productivity. One needs only to look at the vast increase in material welfare of the Western world over the last three centuries for evidence of this. Generally speaking, results indicate that, independent of other factors likely to increase farm size, publicly financed R&D has tended to increase average farm size, the number of large, 1,000 plus acre farms, and large farms as a percentage of the total.

We shall assume that further economic concentration in agriculture is not desirable. Such concentration is likely to drive prices up in the long run, permit certain large farms to unduly control local or regional markets, and undermine domestic food security, as is discussed in detail in our new book "Food Security in the United States" published by Westview Press. What, then, are the policy options that might be pursued?

While our study indicates that agricultural R&D has encouraged concentration in farming, it should be remembered that there is nothing inherent in agricultural research that requires that this relationship be present. Therefore, redirection of research might yield different results. A study sponsored by ESCOP in 1981 revealed that only about 10 percent of all research was clearly directed to larger farms. This figure does not appear unreasonable. What is more likely to be the case is that the interaction between research and the larger social milieu encourages larger scale units. Consider some of the problems:

First, specialized research tends to be applicable only on specialized farms. Thus, successful farmers have tended to specialize in the production of one or a few commodities. This, in turn, demands the necessary capital to take the risk of literally putting all one's eggs in one basket. More interdisciplinary research that looks at farms as socioeconomic and ecological systems might well reduce the bias toward highly capitalized enterprises.

Second, research goals may reflect hidden biases against smaller operators. For example, when the tomato harvester and associated tomato varieties were developed in California, the machine was only profitable on farms much above the average size. Procedures for monitoring and forecasting the effects of research on farm concentration, perhaps along the lines developed by Friedland and Kappel, in their 1979 study cited in my statement, might be developed.

Third, to date larger, better capitalized farms have tended to have better access to research agenda setting than smaller farms. Advisory groups to public research agenda setting than smaller farms. Advisory groups to public research organizations tend to represent larger farms. Thus, research agendas tend to favor the needs of larger producers. Reorganization of advisory groups to serve a cross section of farmers, as well as other interested groups, might also tend to reduce large producer bias.

Fourth, the recent shift away from Hatch formula funds and toward larger corporate grants and contracts from input suppliers and output processors, may serve to exacerbate some of the problems noted above. In addition to the potential conflicts of interest noted in the 1983 NASULGC report on biotechnology, such grants may further bias research toward large producers.

In particular, it should be remembered that the scale of operations that will maximize corporate profits may not be the scale that maximizes farmers' profits. Increased Hatch funds and careful attention to the scale implications of both Hatch and corporate grants could serve to mitigate these problems.

In short, redirection of research appears a viable policy option. Nevertheless, by itself it is inadequate. It must be accompanied by a change in the larger social environment. Farming has always been a risky business. At any time, weather changes can and do reduce yields. In addition, the socioeconomic environment of farming in the United States has been far from stable.

In such an environment, only those who can afford to take risks remain in the business of farming. Those who cannot, sell their farms or make farming a secondary occupation. The risk takers, of course, are those who have the necessary capital.

This suggests another way in which concentration in the farm sector might be abated: by programs specifically designed to equalize the availability of credit, costs of inputs, access to markets, et cetera. Such programs would compensate for farm size differentials and capital endowments.

The basis for the next part of my statement derives from a National Science Foundation, Program on Ethics and Values in Science and Technology, grant to examine the impacts of the new plant biotechnologies on plant breeding. Methods employed in this study have included a review of the relevant technical literature and interviews (to date) with about 50 scientists and administrators in both the public and private sectors.

What, then, are likely to be the effects of the new plant biotechnologies on agricultural research and agriculture?

First, the range of disciplines found within the State agricultural experiment stations will change dramatically. Traditionally, agricultural experiment stations have housed large numbers of plant breeders. These breeders have been seen as the central figures in public sector plant improvement. Microbiologists and molecular geneticists, on the other hand, have been located in basic science departments often located in colleges of arts and sciences or medicine. In recent years, however, this relationship has begun to change. As plant breeders have retired, it appears that many have been replaced by microbiologists and molecular geneticists.

The substitution of molecular biologists for plant breeders also reduces the capacity of the stations to produce finished material.

Second, another consequence of the new biotechnologies is a clash among scientific disciplines. The new biotechnologies were developed in microbiology and biochemistry. Conventional plant breeding, on the other hand, has traditionally dealt with whole plants rather than cellular or subcellular material. Members of each of these disciplines tend to approach those in the other disciplines somewhat hesitantly.

Breeders find microbiologists naive in their understanding of the complexities of higher plants. On the other hand, microbiologists find plant breeders naive in their lack of understanding of genetic pathways at the molecular level. In addition to subject matter differences, biotechnologists and breeders differ with respect to background, work environment, and location within the scientific community.

Ultimately, however, these barriers are likely to break down, if for no other reason than the enormous pressure being put upon scientists to cooperate. It is likely that those few scientists trained in both biotechnology and conventional breeding will play a pivotal role in the transition to a new form of scientific organization. Particularly in the private sector, endeavors will be interdisciplinary in nature. On the other hand, many, if not most, of these new scientists will have virtually no connection to farm life.

Third, there is likely to be a significant increase in the concentration of scientific talent at a smaller number of public and private institutions. Every State could afford, and has had, a conventional plant breeding program. Every State cannot afford and will not be able to have a comprehensive plant biotechnology program. In fact, it is highly unlikely that all the biotechnology institutions now in existence will still be in existence 10 years from now.

In particular, the relative scarcity of scientists trained in the new biotechnologies and the strong demand for such scientists by the industrial sector have made it necessary for experiment stations to offer salaries considerably higher than those offered to plant breeders. In addition, the instrumentation currently used for biotechnological research is particularly expensive. In short, there are real barriers to the mounting of a full-fledged biotechnology program in each State. The short-run effect is likely to be one of the concentration of scientific talent in a few States.

Fourth, a significant constraint is likely to develop in educating new scientists. In addition to the fact that few scientists are qualified to offer graduate education in the new biotechnologies, many of those who are qualified are working in industrial settings or in biotechnology units in which little teaching is conducted.

As a result, the flow of new scientists into these fields is likely to be relatively small for the near future. In the long run, however, the decline of conventional breeding in the public sector poses the more serious constraint. If the public sector ceases the production of finished varieties, then who will train plant breeders to produce such varieties for the private sector?

Fifth, the amount of effort devoted to research on minor crops may decline. Instead of using the new biotechnologies to increase the number of food crops available to the human population, or to increase the role of crops of currently minor significance, most of the financial support for the new biotechnologies is being used to increase productivity of major food crops.

This is in part a function of market size. Clearly, the existing markets for major crops are larger, and hence of greater interest to the private sector. As a result, the private sector not only is investing most heavily in major crops; it is pressuring the public sector to focus on these crops as well.

The public sector is also focusing on major crops as a result of State and national funding practices. Not surprisingly, the commodity groups that are most powerful tend to represent the major crops. With public funds available for biotechnology programs on only a few crops, research is likely to follow the interests of the most powerful commodity associations. Even in the case of adjoining States with similar crop mixes, competition rather than division of labor appears likely.

Sixth, a major increase in the size and scope of the commercial seed industry is beginning to take place. More and more, the small seed companies are being relegated to servicing specialized local markets, while the large seed companies capture most of the market for major crops. At the same time, the large seed companies can afford to engage in significant R&D expenditures.

Large seed companies have also begun to apply pressure to experiment stations to cease producing finished varieties. This shift from the public to the private sector in the development of finished varieties has changed the type of varieties being produced. In particular, researchers in private firms tend to emphasize hybrids over varieties as hybrids must be purchased by farmers year after year.

In addition, the new biotechnologies tend to be utilized by private companies in ways quite different from the ways they might be utilized in the public sector. For example, at least one firm is utilizing tissue culture techniques as a way of identifying corn varieties that are resistant to herbicides produced by that company. Eventually, such herbicides would be sold with seeds as a package to farmers.

Seventh, the new biotechnologies are also likely to have rather dramatic effects on farmers. Thus, farmers are likely to be faced with a bewildering array of seed varieties. Farmers are also likely to be gradually eased out of their traditional roles as the primary clients for plant breeding research. They will be and already are being replaced by seed companies and the chemical companies that run them. Neither scientists nor administrators appear aware of the potential for conflict between the interests of farmers and those of agribusiness.

Linkages between government, university, and industrial research are being rapidly reformulated. Disciplinary relationships are also being rethought. These changes will be fraught with conflict. Some organizations may not survive the transition.

Policy implications: perhaps the major policy implication of this study is that certain aspects of the new biotechnologies are unlikely to be developed unless Federal money is available for research and education. While State and private funds are already addressing some issues effectively, much of the potential for the new plant biotechnologies will only be realized if Federal moneys are made available in a relatively unfettered manner.

In addition, given their potential long-term significance for altering American agriculture and agricultural research, Congress should give serious consideration to monitoring continuously the progress in this area. While the methods for assessing the impacts of scientific and technical innovations are still in their infancy, they do offer substantial promise for insuring that the public interest is served.

This concludes my testimony, Mr. Chairman. I will be pleased to respond to any questions you or any member of the subcommittee may wish to ask.

[The prepared statement of Mr. Busch appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you. That the last comment with regard to monitoring is particularly pertinent because that is one of the things that the subcommittee is suppose to do, although it probably does not do it very well. However, we have additional mechanisms including the work that is done by our Office of Technology Assessment on which we have heard testimony this morning that may be able to play a more consistent role than we do in this subcommittee.

Dr. Lacy, I would like to have you proceed with your testimony.

STATEMENT OF WILLIAM B. LACY, COCHAIR, COMMITTEE FOR AGRICULTURAL RESEARCH POLICY, UNIVERSITY OF KENTUCKY

Mr. **Lacy**. Mr. Chairman, members of the subcommittee, I appreciate your invitation to comment on agricultural policy issues facing our research system. Today I would like to share some observations on an issue which is being examined in detail by your committee, the research policy and the priority setting process and its impact on the research system itself.

The process of developing effective national agricultural research policy was stimulated by title XIV of the Food and Agricultural Act of 1977. As you know, three new coordinating bodies were established to improve the planning, coordination, and management of agricultural research within and between the various USDA, Federal, and State agencies: The Joint Council on Food and Agricultural Sciences; the Subcommittee on Food and Renewable Resources of the Federal Coordinating Council on Science, Engineering and Technology; and the National Agricultural Research and Extension Users Advisory Board. Initially, there was skepticism and confusion about their role and utility.

In recent years, however, this has begun to change with the institution of some significant internal evaluations and the setting of annual priorities. In addition, there are increasing efforts to conduct long term needs assessments of food, fiber, and forest products, and to build the research capacity required to address these needs. The Needs Assessment for Food and Agricultural Sciences is a significant document for improving the priority setting process.

With the progress of priority setting and needs assessment processes have emerged a number of related questions. To what extent will this process influence and affect the way in which science is conducted in the laboratory, greenhouse, field and office? From work my colleague, Dr. Busch, and I have conducted, the initial conclusion is that the impact will be negligible. In a survey of over 1,400 principal investigators engaged in agricultural research at institutions that receive Federal agricultural funds, disciplinary criteria and personal enjoyment were identified as the main reasons for doing research, not the national priorities.

Scientific curiosity and publication probability in professional journals ranked high as reasons for choosing a particular problem, while priorities of the research organization ranked 11th out of 21 criteria and the idea that the topic was currently a high priority or "hot" topic ranked 15th.

It shouldn't surprise us, however, that disciplinary criteria dominate the decisionmaking process for a scientists' research agenda. Our survey also revealed that scientists in many agricultural disciplines have little exposure to other disciplines in terms of formal education or formal and informal communication.

In addition, U.S. agricultural scientists view disciplinary journals as their major resource of research information, the most important outlet for their findings and the single most important criterion for institutional rewards and promotion. Moreover, scientists overwhelmingly emphasized the creation of disciplinary knowledge and the increase of agricultural productivity as the most important goals for agricultural research. Many other goals, such as improving human health and nutrition, and improving communities, tended to be relegated to one or two disciplines. Moreover, these disciplines tended to have fewer scientists and a more marginal role in the agricultural science system. In addition, there is a strong relationship between those goals to which scientists see their research as contributing and those goals perceived as intrinsically important. In general scientists tended to undervalue or be relatively unaware of the value of the research of other agricultural disciplines. Such findings highlight the need for a more informed agricultural research policy. They also suggest that the impact of the national established priorities may be minimized by the disciplinary structure of agricultural science.

Many of the emerging national research priorities, however, are disciplinarily oriented. Furthermore, scientists identified as important criteria for their research choice the availability of research facilities and funding. Consequently, if the priority setting process can be more effectively linked to the provision of funds and facilities, it is likely to have a greater impact on bench scientists.

Congress and the agricultural research community need to combine effective priority setting with sufficient resources for sustained efforts to meet long-term needs, while retaining the flexibility to respond to urgent short term problems and coordinating the overall effort.

Perhaps the greatest impact of the priorities may be through their influence on the hiring policies and practices of departments and institutions. Substantial recruitment of new scientists will be important in the coming decades if the agricultural sciences are to retain their vitality and address the new research frontiers, particularly in the basic sciences.

Research positions generated through increased funding or retirement of older scientists, could be filled in accordance with carefully developed long-term national research priorities. However, this should not be done at the expense of the existing programs which, according to most observers, are already underfunded.

A number of the important emerging priority areas, as well as those that are likely to emerge in the future, will require interdisciplinary skills and training. Increasing the capacity of the current system to engage in interdisciplinary research may require not only changes in the training of scientists, but modifications of (1) research strategies and methodologies as well as (2) organizational structures. Some suggestions for accomplishing this are as follows:

Graduate students could be provided fellowships or assistantships to pursue minors outside of their disciplines. For example, some agronomists might be encouraged to minor in animal nutrition.

Faculty could be funded to take sabbatical and postdoctoral leaves at nonland grant institutions and in disciplines other than their own.

The current reward system in agricultural research institutions also needs to be reorganized so as to encourage scientists to pursue more high risk, interdisciplinary and long-term research. University administrators often seek standardized measures for evaluating the performance of all faculty and ignore the special roles of agricultural research. Better systems for promoting and rewarding high quality research that addresses national priorities need to be developed.

Finally, administrators should consider the establishment of several multidisciplinary, multicommodity research projects and programs. Some creative efforts in this area are just beginning to develop. For example, Integrated Pest Management, IPM, is an innovative multidisciplinary research strategy which promotes the development of pest control methods employing a combination of biological, mechanical, and chemical means.

Farming systems is a second multidisciplinary, multicommodity research strategy which has developed over the last decade largely out of the experiences of the International Agricultural Research Centers. While far from a reality even in these centers, it provides a model that could refocus the emphasis in agricultural research away from disciplinary and commodity concerns toward complex interactions among and between people, crops, soil, and livestock.

Other new interdisciplinary structures which are emerging are: First, solutions to Environmental and Economic Problems, a Federal and State funded, multidisciplinary research effort to develop new techniques and strategies to control soil erosion in the croplands of Washington, Oregon, and Idaho, and, second, the Collaborative Research Support Programs, funded by U.S. AID and agricultural colleges, multidisciplinary interuniversity programs which involve U.S. social and natural scientists collaborating on both basic and applied research with similar groups from developing countries.

Many of these institutional arrangements require new and creative funding, since neither the existing competitive grant nor the existing formula funding model are effective in stimulating multidisciplinary research across State boundaries with the aim of addressing regional or national agricultural priorities.

In addition to a more effective linkage between the priority setting process and the world of the scientist, there is a continuing need to analyze and review the policy process itself. The efforts to date are to be commended. They could be improved further by the following actions: First, given the importance of agricultural research priorities, consideration should also be given to including the full range of constituents for agricultural research in the process of developing priorities; second, in addition, the process could be improved by the establishment of several multidisciplinary units in which policy research could be conducted.

Finally, the development of policy requires the ability to make judgments about the value of alternative research priorities, the ability to assess the results of policies once they are implemented, and eventually the ability to develop forecasting techniques. A number of increasingly powerful methodologies are being developed for interpreting scientific, technical, and economic information in order to increase the effectiveness of research efforts.

In addition, methodologies are beginning to emerge which attempt to assess the results of policies, forecast the consequences, and integrate technical, economic, social, aesthetic and moral considerations. Although formal social impact assessment of changing technologies in U.S. agriculture is still in its infancy, researchers utilizing this approach have provided insights on such topics as the socioeconomic consequences of automated vegetable harvesting, tobacco harvesting, center pivot irrigation, and organic and no-till cultivation.

Resources should be devoted to these new methodologies if they are to move beyond their infancy and contribute to effective research resource allocation and priority planning. Furthermore, efforts should be devoted to preparing scientists to utilize these methodologies and assessment strategies for agricultural research.

Moreover, research planning will require closer collaboration among natural and social scientists as planners address not only the possibilities of advancing knowledge or technology, if particular resource appropriations are made, but also consider the value to society of the new knowledge or technology.

Finally, to meet the diverse and complex research agenda for a long-term, sustainable, nutritious and equitable food sytsem in the United States will entail levels of public funding of agricultural research more commensurate with its value to society and with its research needs.

This concludes my testimony. I appreciate the opportunity to share this with you.

[The prepared statement of Mr. Lacy appears at the conclusion of the hearing.]

Mr. **Brown**. You haven't gone as far as Dr. Farrell did this morning in his paper in which he made some rather specific recommendations as to the level of research funding that would be necessary over the next 10 to 20 years.

Mr. **Lacy**. No.

Mr. **Brown**. You didn't hear his testimony this morning?

Mr. **Lacy**. I did not, sir.

Mr. **Brown**. Basically, he outlined the process for it in his paper. It included the increasing cost of research, the increasing size of the problems, the world food problem and so on that there should be something in the neighborhood of a 10 percent per year real increase in agricultural research funding for the next 10 years, and then a maintenance of that new level for another considerable period of time.

It is not clear to me the exact analytical basis on which he comes to that. I wonder if it could have been the subject of any of your research.

Mr. **Lacy**. Only indirectly. I am not an economist. I am a sociologist and social psychologist. I haven't focused so much on the financial aspect of funding of public sector research. I am familiar that the assessments by men like Vern Ruttan suggest in order to maintain an agricultural system that is becoming increasingly complex, that the research required for just maintenance research is consuming larger and larger percentages of the research funding.

I am also well aware, as you are, that agricultural research funding at the Federal level has been considerably less than any other sectors of the Federal funding of research and R&D. And the State portion is in a number of cases, three and four times the portion of the Federal matching.

Mr. **Brown**. Now one or the other, I think it was you, Dr. Busch, indicated that the agricultural research system was not being particularly responsive to these priority setting mechanisms, which we have established because of the propensity of scientists to follow their own areas of interest, which of course is good scientific procedure.

I would like to inquire as to whether you thought through the implications on that phenomenon of a major shift toward competitive grants funding rather than formula funding? Would competitive grants funding tend to give a greater emphasis to the national priority-setting process as compared with formula grants funding?

Mr. **Busch**. I think the immediate answer one would give would be yes, but I think this ought to be qualified in that there are probably certain kinds of research that are unlikely to be accomplished through competitive grant mechanisms and others that are better accomplished through a competitive grant mechanism.

I think I would agree with the comments that were just made with regard to these. There is an advisory board with regard to competitive grants in the biotechnology area; that certainly is one way and there is no question from our studies that scientists do respond to the availability of funds.

But, I think one has to be very careful here. It is virtually impossible and probably a bad idea to so carefully specify precisely what we will be doing with a particular sum of competitive grant funds that scientists are forced to approach problems within a very narrow framework.

What that means in other words is that scientists always have latitude within even a competitive grant to do things according to what they see as the most desirable way to do them. If I may suggest, it seems to me that the question of how scientists are rewarded in a broader sense is particularly pertinent here, a point that my colleague just mentioned a moment ago—one of the ways in which scientists are rewarded is that administrators tend to like it if scientists bring in a substantial amount of money through competitive grants or other mechanisms.

But in addition to that, scientists tend to be rewarded for doing things that will result in lots of publications in scientific journals and doing that in a relatively short time context. What that means is that, even in competitive grants, and perhaps more so in the case of competitive grants, where we are talking about a 2-, 3-, 4-year time horizon, the tendency is going to be focused on those problems that can be resolved within a very short time horizon.

There may be some advantage, some significant advantage to longer term kinds of funding and in fact conventional plant breeding, where you may be talking about 10, 15, 20 years to develop a new variety, has relied very heavily on that kind of longer term mechanism.

So I think you have to look on the one side of what scientists see as the rewards and the other side what are the carrots that Congress or research administrators can provide to get scientists to move in a particular direction.

Mr. Brown. This is a problem that extends throughout science, not just agricultural science. I talk to any number of scientists who have been very successful under competitive grant conditions funding by NSF or NIH or other agencies who complain bitterly at the amount of time they had to spend writing grant proposals and doing all the other sorts of things that they see longingly not happening in the formula grants system.

And they wish that they had something closer to that. Of course neither system is perfect. Good science can exist and flourish under both conditions and it needs a sensitive management to assure that you are getting the best science as well as contributing to whatever social goals we may be trying to achieve at that particular time.

Another one of those social goals that you both touched on, I think, is the growing need for some loosening of the disciplinary boundaries within science and we had some interesting testimony yesterday reporting on the work of the McKnight Foundation which was supporting basic plant science and was using a certain amount of its funds for individual research and a certain amount for interdisciplinary group research in order to achieve its collective goals for the improvement of science.

Now, there is no reason why the Department of Agriculture couldn't do the same thing as far as I can see. In other words, to encourage the interdisciplinary research through either a granting process or even through some more heavyhanded process like making that a requirement or a certain amount of the requirement for continued levels of funding.

Mr. Lacy. By the way, Mr. Chairman, there is one example of that effort being done between three Northwestern States on the issue of soil conservation that I mentioned in my testimony, called "Solutions to Environmental and Economic problems." It is regionally funded by the USDA, and includes natural and social scientists in three different States. It is just the first exploration into this area. But I think there needs to be a mechanism that links such research projects to the reward structure that those scientists are participating in in order to encourage it on a long-term basis.

Mr. Brown. Basically, our problem is not the scientists or the quality of the science, but the goals towards which we manage scientific endeavors—I am particularly intrigued by your remarks about the impact of research on the structure of agriculture.

What is the desirable structure? That is the policy issue I don't think any of us has resolved. But, obviously, we could, if we could solve the policy issue, direct research in such a way as to complement that policy decision.

It doesn't necessarily have to be that research contributes to large-scale farming if we didn't direct it in such a way that it did.

Well, I would like very much to pursue these issues, but I am more interested in having them opened up as a part of the record so that we would broaden our thinking a little in connection with next year's restructuring of the farm bill.

I very much appreciate your contribution to that. Thank you.

Mr. Busch. Thank you.

Mr. Lacy. Thank you, Mr. Chairman.

Mr. Brown. Our next witness will be Dr. Perry Adkisson, who has been of assistance to us before. He is deputy chancellor for agriculture at Texas A&M. He will talk about IPM and biocontrol progress.

STATEMENT OF PERRY L. ADKISSON, PROFESSOR OF ENTOMOLOGY AND DEPUTY CHANCELLOR, TEXAS A&M UNIVERSITY SYSTEM

Mr. Adkisson. Thank you, Mr. Chairman. It is a pleasure for me to be here. I appreciate the invitation to appear before you and your committee.

I will be wearing two or three hats.

Mr. Brown. Just make sure we know which hat you are wearing.

Mr. Adkisson. I am going to be wearing all three of them, because I need them with my hairstyle.

I am a professor of entomology, and I am involved in research in addition to being deputy chancellor, and I am executive director of the Consortium of Integrated Pest Management, CIPM, a group of 16 major land grant universities that are conducting research to develop improved integrated pest management systems for all the pests, insects, diseases, weeds, and nematodes of several major crops.

It is a privilege for me to appear before you today, and I appreciate your inviting me to testify on the current status of integrated pest management and prospects and needs for the future.

Integrated pest management is a system of pest control which combines the use of all available tactics—cultural, chemical, and biological—to suppress pests below crop damaging levels. It is a common sense approach to crop protection wihch works in harmony with nature—not against it. Integrated control uses cultural, chemical, and biological control methods to attempt to suppress pests while preserving insect parasites and predators. That is a major point that separates integrated control from chemical control. We try to use insecticides sparingly until pest numbers reach crop-damaging levels. They are used judiciously and selectively to suppress pest numbers with minimum damage to natural enemies or the environment.

This is not a new concept. It has been around for a long time. It was not until the late 1960's and early 1970's, when it became apparent that insecticides were having adverse effects on many nontarget organisms, that IPM was seen as a way to conserve both crop yields and quality of the environment.

Concomitant with the banning of DDT in 1972, the U.S. Environmental Protection Agency and the National Science Foundation funded the first large national project to develop alternate methods to insecticides for crop protection. This project, entitled "Principles, Strategies, and Tactics of Pest Population Regulation in Major Crop Ecosystems," and known as the Huffaker project, for its director, Dr. Carl Huffaker of the University of California-Berkeley, brought together more than 250 scientists from 18 major land grant universities to develop IPM systems for six major crops.

Mr. **Brown**. If I may interrupt, that is a fascinating bit of history I was not aware of.

Have there been subsequent efforts of a similar scale?

Mr. **Adkisson**. Yes, sir. The Consortium of Integrated Pest Management program is also of this scale.

The Huffaker project, was funded through 1978. It was the first project to take a holistic approach. It brought together operations research specialists and computer specialists in an attempt to design research models that simulated growth processes of plants and insects and mites that attack them.

Using this, we tried to identify the gaps in research that we need to do in terms of crop-resistant varieties, biological control processes, and insecticide treatments, to try to develop a unified, integrated management system that minimizes the use of chemicals. The Huffaker project was terminated in 1978 and was succeeded by the Consortium for Integrated Pest Management project. And this included most of the universities that were involved in the original project, the Huffaker project, except that we tried to use the knowledge and methodologies we developed in earlier projects to focus on all pests.

The Huffaker project was an insect-mite project. The Consortium project focused on all pests and their interactions as they affected the crops that we were working on, which are alfalfa, apples, cotton, and soybeans.

This project was funded by the EPA during 1980-1982, and then in late 1982 the funding was transferred by OMB over to the USDA Cooperative State Research Service. The project will terminate early next year.

As I mentioned, the CIPM project built on the systems approach developed by the Huffaker project. I think these two projects have done more to bring systems types of concepts and philosophy and techniques to research than anything else.

The project did two or three things in addition to what was done in Huffaker's project. One thing we did was place more emphasis on breeding for pest-resistant crop varieties and the use of economic models to analyze the impacts of new technologies. We had a belief that we had to show farmers that any new technology that came in had to be more profitable than what they were using or they would not use it.

The other thing we did was we formally linked the Cooperative Agricultural Extension Service pest management programs with the research programs. We did this in an attempt to shorten the lag time between the development of new control tactics and implementation by farmers. I think we have done that very well. The extension service has done an excellent job training farmers in the use of IPM and in the development of field scouting services. And I believe most of the crop producers in the United States—at least the ones I talked to—are all aware of IPM. They don't always use the technologies, but they are aware of it.

Many critics—and we have a number of them—say IPM is an ivory tower approach to crop protection; it has never been implemented on a large scale. But I think the facts prove the contrary, and history is beginning to show that IPM has been a very profitable way for farmers to protect their crops, and it has been implemented on a large scale.

We have had a lot of cost-benefit analyses made in Texas with our programs, and they show in cotton—one of the largest programs—that farmer profits can be increased $25 to more than $100 per acre over conventional practices. In fact, our Agricultural Department has estimated the value of IPM to the state economy exceeds $300 million a year.

In the Northeastern United States, IPM has produced savings to alfalfa growers of $25 to more than $100 an acre. That has been achieved through reduced use of pesticides. In alfalfa in the North Central region, it has saved $25 per acre, and insecticide use was reduced by 75 percent.

One of the most exciting things that came out of the project is that the USC research group on alfalfa is developing ways to increase returns by more than $25 per acre. In California alone, this will more than repay all the State-Federal funds expended on IPM, because, as you know, alfalfa is a very expensive crop to plant and get to a stand.

In terms of environmental quality and savings to farmers, recent USDA statistics suggest recently that from 1971 to 1982, insecticide use on cotton has been reduced from 73.4 million pounds to 16.9 million. This is a 77 percent reduction. And I am happy to report to you that cotton is no longer the largest consumer of pesticides in the United States—corn is.

On grain sorghum, the insecticide use has been reduced from 5.7 million to 2.5 million pounds—a 56 percent reduction; and on peanuts, 6 million to 1 million—an 83 percent reduction. So I believe these statistics show that we have been successful in developing IPM programs that reduce the use of insecticides. They have been implemented on a large scale.

We have done this without any reductions in yield. In fact, in some cases yields have been increased.

Economic analysis has been widely used in IPM research to demonstrate cost benefits of emerging technologies when compared with old. In fact, the CIPM project is the only large crop production research which project included an economic research unit in every crop research team.

In addition, until recently the USDA Economic Research Service had a substantial group involved in pest management research providing quite a lot of grant funds for efforts in the individual states for these types of analyses. But these efforts have recently been terminated and, as far as I know, they are no longer doing any research in pest management.

But, as I mentioned previously, I think this has been one of the most important contributions in getting farmers to adopt these practices. You show an American farmer how he can reduce cost or increase the bottom line return, and he will do it—and do it very, very quickly. So I think this type of research should be continued.

The priorities for research in extension have been established by the research scientists and specialists working in the field. They have been aided by farm advisory groups and pest management associations. In addition to that input, they have used techniques of the system scientist to develop computer models of the systems which identify knowledge gaps that should be filled.

The computer models have been extremely valuable to us in simulating growth processes of plants and impact of pests on plants and other environmental processes, on yields and on the way plants grow. These techniques have been highly successful in guiding research and allocating and reallocating funds to the area of highest priority.

Still, much research needs to be done in IPM. We should continue the momentum produced in the Huffaker project and CIPM project by maintaining their unique organizational structure for managing complex multidisciplinary research involving several States. There is a need to maintain the systems-oriented research teams that are in place, and the teams of economists working on cost benefits of IPM, and the total crop production system, as related to production and environmental quality.

We need to keep in place linkages between the IPM researchers and the Extension Pest Management program. Unfortunately, it appears that much of this momentum will be lost when the CIPM project is terminated next year.

There are many new areas of research that can benefit from crop protection. Emerging biotechnology may develop new types of crop varieties that are resistant or less attractive to pests. This is an area on which we ought to put a great deal of funding and emphasis.

You have heard mentioned by previous speakers that there are chances to develop crop varieties that can withstand environmental stress, such as salt and salinity, and be resistant to certain herbicides. We may be able to clone pesticide-resistant genes into insect parasites and predators. If we could do this, we could have natural enemies that are resistant to a pesticide, which the pest is susceptible to. This would be a tremendous benefit to us.

We could also use biotechnology to produce more strains of insect pathogens and perhaps more selective biological pesticides.

In addition to biotechnology aspects, there is more conventional research to do, particularly on multiple pest interactions and pest forecasting and environmental modeling, on computerized decision-making and development of new biological and cultural control methods. There is also a great deal needed to be done on selective use of pesticides to minimize development of pesticide-resistant pest strains.

Unfortunately, in spite of the results produced to date and the need to continue the above research in a highly coordinated, unified way, IPM is no longer a high-priority item with Federal budget makers. Allocations for IPM have not been included in recent USDA/CSRS or Federal Extension budget submissions to Congress. Indeed, you have had to replace these at the request of the producers and farmers and the scientists involved in the various projects.

In my opinion, this is something that should be corrected. Some provision should be made for USDA, EPA or the National Science Foundation to fund large consortium projects where the universities can combine the Nation's best scientific talent to conduct research on large national projects that require large multidisciplinary resources not available in any single institution.

In summary, we need to develop some new models for managing agricultural research in this country. The CIPM model is one. It has been highly successful. But it is not likely to be continued.

Thank you.

[The prepared statement of Mr. Adkisson appears at the conclusion of the hearing.]

Mr. **Brown**. Dr. Adkisson, I think something is happening you have not been too explicit in. You indicated the development of IPM as a valuable resource for agricultural producers, a field in which they set their own priorities. I think you have indicated here basically in the field they would do that by farm advisory groups and pest management associations.

In your projects, there wasn't a very high participation by high-level bureaucratic structures as we have set up here in the bill. Your structure seemed to work fairly effectively, if I read your statement correctly.

Mr. **Adkisson**. Yes, sir.

Mr. **Brown**. And then something has happened to the priority which either the Department or the Congress has given to this field of activity, maybe even at a time when it was beginning to be particularly effective.

What is this line you have here about allocations for IPM have not been included in recent USDA/CSRS or Federal Extension budget submissions; "Indeed, they have been replaced by Congress at the request of the producers and the scientists involved * * *."?

Did you recommend they cut the funding for that?

Mr. **Adkisson**. No, sir. I have been involved in getting it reinstated.

Mr. **Brown**. What is the meaning of your statement here, then?

Mr. **Adkisson**. We have had items in the special grant funding in the Cooperative Extension Service, which has had substantial funds for pest management programs. In the USDA budget submissions that came to the Hill in the last 2 or 3 years, those items have been left out of the budget. We have had to come back in and reinstate those. Those of us—supporters and the farmers we work with—work to get them reinstated.

I have been involved in it for about 3 years getting our delegation to help reinstate those funds.

Mr. **Brown**. I have just had the opportunity within the last year to notice some of this tremendous impact in California. Last summer, we had hearings on cotton pest management in southern California, which were startling to me in indicating the impact that IPM was having on the cotton industry in that section of the country. There was a whole new breed of technical people working in the field to inventory pests and to advise the farmer on the better use of pesticides.

Where is the resistance coming from? Would you care to identify where?

Mr. **Adkisson**. I am not sure I can do that. I think it is just a matter that——

Mr. **Brown**. It isn't some of your Texas chemical companies that see a lost market?

Mr. **Adkisson**. No, sir; I don't think so.

We have a similar program in Texas to what you have in California. We have a lot of State support for that program, such as in California. I think it is just a matter that the emphasis—you know, IPM has enjoyed through the seventies and early eighties sort of a favored role, and now biotechnology has moved in and we are no longer——

Mr. **Brown**. You are saying that some people are treating it as a sort of a fad being replaced by another fad; is that right?

Mr. **Adkisson**. Yes, sir.

Mr. **Brown**. That is not a proper way to treat a scientifically valid strategy for improving agricultural production.

Mr. **Adkisson**. That is true.

I think, as one of the previous speakers indicated, it has provided the model for organizing and managing multidisciplinary research.

Mr. **Brown**. That is precisely the direction we need to go.

Mr. **Adkisson**. Precisely the direction we need to go, yes.

Mr. **Brown**. I still don't quite understand. Personally, within the structure of Congress, I never did feel that IPM had really caught on as much as I would like to have seen it catch on.

I would agree with you that it enjoyed a certain level of support, which seems to have faded. But this lower congressional priority was out of ignorance more than anything else.

Mr. **Adkisson**. Yes.

Mr. **Brown**. I can't believe that at the high levels of our Department of Agriculture that same feeling would prevail.

Mr. ADKISSON. I don't want to believe it, either. But I am telling you that it is true; and that in the budget submission for the 1985 budget that came out of the Department of Agriculture, the funds for IPM in both the federal extension service and in the CSRS Special Grants Program were omitted and have been reinstated, because I was just today with Congressman Hightower to check the status of that. He reported they were successful in reinstating it.

Mr. BROWN. There are wheels within wheels; sometimes the department does the right thing and Congress does the wrong thing. And sometimes it is the other way around. I am never quite sure which is which.

Mr. ADKISSON. Anyway, as you know from visiting with the California program, and in Kentucky and many other places, the success is beginning to show up. In the long term, success is good; and you sure can't argue with the kinds of figures that are coming out on the economics and on the environmental issues.

Mr. BROWN. I am extremely interested in this history on this very significant area of scientific research, and I will try and look into it a little further myself and see if we can help to correct that.

But I am also quite interested in the implications of this on the processes for agricultural research planning. It bears very directly on that.

Mr. ADKISSON. I think that is very important, and I hope that you will look into that.

Mr. BROWN. Thank you very much, Dr. Adkisson, for your excellent testimony.

Mr. ADKISSON. Thank you, sir.

Mr. BROWN. Our last witness will be Dr. Jerome Weber, and he will contribute to our understanding of the same general area.

STATEMENT OF JEROME B. WEBER, PROFESSOR, CROP AND SOIL SCIENCE DEPARTMENTS, NORTH CAROLINA STATE UNIVERSITY

Mr. WEBER. Thank you, Mr. Chairman.

Mr. BROWN. You don't need to read this whole statement, Dr. Weber, if you don't feel like it.

Mr. WEBER. I am certainly not going to, Mr. Chairman. I will summarize.

Mr. BROWN. I will put the whole thing in the record, and you can highlight it for me, if you will.

Mr. WEBER. All right.

My position at North Carolina State University was created in 1962 by funds from State and Federal sources initiated by the appearance of Rachel Carson's book, "Silent Spring." My initial duties were to stress the processes involved in the fate and behavior of herbicides in the environment. I was, in effect, to be the devil's advocate with respect to the environmental safety of agriculture pesticides.

For the past 22 years, I have carried out this assignment and published over 100 research publications in scientific journals and books. My consulting activities have taken me to many countries and have involved environmental problems caused by toxic-organic chemicals, including pesticides.

I will move to my testimony. It is my understanding that I am to provide members of this subcommittee with information concerning the environmental safety of pesticides and future needs and opportunities. To do this, I have asked myself eight essential questions concerning pesticides. I will attempt to provide you with my answers to these questions, and will be citing approximately 100 references as documentation.

Answers to the first questions are primarily historical, and I will not touch on them in my oral presentation. Because of the shortage of time, I would like to skip to question No. 5.

I will say that I think it is somewhat fortunate that the book "Silent Spring" and the other 8 or 10 books like it that question pesticide use in the environment came along because, at the time, we were very strongly involved in applied research in agriculture with not as much basic research as we probably should have had; and if they had not appeared when they did and criticized us, we would still have with us DDT and all the other chlorinated hydrocarbons and some of the others, perhaps. We might have changed that, but I am not sure.

In question 5, I ask the question: Are the pesticides presently being used safe to the environment? Considering the extensive and critical evaluation of pesticides in the environment by both scientists and nonscientists alike, as exemplified by the nearly 200 books published and cited in the reference section of this testimony, one would have to conclude that although some environmental problems occasionally occur, pesticides by and large are environmentally safe to use.

It is true that some of the early pesticides, such as the chlorinated hydrocarbons and toxic heavy metal compounds, did have adverse effects on the environment. But these materials have been removed from the marketplace, or are registered for restricted use only.

It is not possible for me to provide the members of these hearings with an ironclad 100 percent guarantee of the environmental safety of all presently used pesticides, and there are two reasons for this: First, I do not have access to all the information regarding the properties of all the pesticides, as I discussed in question No. 4. And, second, I did not have time to adequately examine all the information available.

The best thing I can do is compare the relative environmental toxicity of a sizable number of presently used pesticides using a scheme that I developed about 8 years ago and which I published in the Journal of Environmental Science and Technology. The scheme is based on four key factors. There are many other factors which could have been included, and these are just used as an example to allow one to compare environmental safety of an assortment of pesticides.

The first factor is acute oral toxicity to rats, which gives one an indication of the mammalian toxicity to wildlife.

Second is the acute toxicity to the most sensitive fish species tested, which gives an indication of the toxicity to aquatic wildlife.

The third factor is the longevity in the soil, which gives one an idea of how long the chemical persists.

The last factor, the bioaccumulation by aquatic organisms, gives us an indication of biomagnification potential in wildlife.

The relative environmental safety of a selected number of approximately 60 commonly used pesticides is presented in table 1. Using my scheme, the most environmentally toxic chemical would have a value of 16; and a chemical with the least environmental toxicity would have a value of 4.

The mean value for the chlorinated hydrocarbon insecticides is 13.9, but it ranges from 12 to 15.3. These chemicals have been discontinued or are restricted use materials. All of the other presently used pesticides have much lower environmental toxicity values that range from 4.4 to 10.4.

Does this mean that the presently used pesticides are environmentally safe? Not exactly. What it means is that the old pesticides that were implicated in the environmental problems have environmental toxicity values two to four times those of the more recently developed chemicals which we are presently using.

Question 6 asks: Are pesticides having an adverse effect on long-range soil fertility? This question I ask because I am getting asked the same question more and more by the public and by my students.

One example I quote is a newspaper article which appeared in the Dallas Morning News and also appeared in the Raleigh Observer. It said that pesticides may damage soil but the farmers are forced to use them. The article cited Dan Langford, a cotton-wheat farmer who says that pesticides are killing the soil. It cited Ron Carroll, an assistant director of environmental studies at Baylor University, saying pesticides may be seriously damaging the delicate chemical composition of the soil and reducing long-term soil productivity.

In the same article, Jim Hightower, Texas agricultural commissioner, stated that pesticides poison the land and mess up Mother Nature. Well, this article is quite typical of many I have read over the past 22 years, and I have asked myself many times: Are these claims valid? What is the evidence for them? I have searched the literature for evidence, to back up the claims stated; but I have been unable to find any. And I can only conclude that the claims are based on primarily speculation.

The hundreds of articles that I have examined and the numerous books published by experts in the field convince me that pesticides which are presently being used are as safe to the environment as commonly used pharmaceuticals are to human health. For both examples, misuse can lead to disaster; proper use can lead to great benefits.

To comment on soil fertility effects, I would like to say that soil fertility is defined as the capability of sustaining abundant plant growth; thus, chemicals which affect soil fertility might affect one or more of a number of processes.

I will delete a great deal of the literature citations and summarize by saying that pesticides have been shown to affect populations of soil bacteria, fungi, and antinomycetes, affect ammoniafication, nitrification, denitrification, and N_2-fixation processes, rhizobia and legume nodulation, free-living organisms, soil pathogens and their antagonists, algae, cellulolytic activity and organic matter degradation, respiration activity and other enzymatic activity. Most chemicals even at normal rates have some form of effect on microbial activity. In most cases, the effects noted are transient, lasting only a few days or few weeks.

It should be pointed out that soil microflora are responsible for 90 percent of the biological respiration activity in the soil, and these microorganisms are very resilient. Recolonization of pesticide-treated soils does eventually occur in all cases.

There is little evidence to show that pesticides have produced or are producing any long-range adverse effects on many soil processes on which soil fertility depends. There is an abundance of evidence to show that the pesticides which are presently in use offer a great many benefits at a very minimal risk.

In question 7, I ask: How does pesticide use fit into agricultural production systems like conservation tillage and organic farming?

With the renewed interest in conservation tillage—otherwise known as no-till, minimum-till, and reduced-till—in order to conserve fuel and minimize soil erosion and water losses, pesticides must fit or new pesticides must be developed to fit. This renewed interest in conservation tillage and the use of good soil conservation practices is a step in the right direction.

Farmers ought to be encouraged and offered financial inducements to use these practices, because both the soil and agricultural chemicals should be kept on the land. Pesticides, in conjunction with other pest control methods, will be as necessary for the continued production of crops as pharmaceuticals are for the continued maintenance of human and animal health.

Question 8: What needs to be done to assure that pesticides are not adversely affecting the environment?

It is my opinion that several tasks need to be carried out to ensure a high margin of safety regarding pesticides and the environment. First, industry should be encouraged to complete the characterization of the chemical, biological, and environmental properties of each of their respective pesticides.

Second, governmental agencies like the Environmental Protection Agency should be encouraged to assemble this information into a handbook somewhat similar to Karel Verschueren's environmental handbook for organic chemicals.

Third, this information should be used to prepare newsy articles for the public regarding the environmental safety of pesticides. This would help dispel some of the public concern about the environmental safety of pesticides.

Fourth, research should be initiated to develop a much more accurate soil test on which to base pesticide rate recommendations. The new test should thus become standard in all soil testing laboratories. The present use of soil organic matter content, as determined by differing and unstandardized methods, and used in conjunction with soil texture, is wholly inadequate. A new, accurate soil test would assure that pesticides would be applied at optimum rates which would control the target pest most economically and then dissipate safely.

Fifth, university soil science departments should be encouraged to initiate new research projects that delve deeply into the basic chemistry of soil humic matter and examine potential benefits from added organic substances which are present or which are added to soils. The soil organic matter project should also examine any benefits which might be derived from the organic farming philosophy.

Organic matter added to soil has long been known to have beneficial effects on soil aeration, nutrition, water holding capacity and other soil parameters. Its merits and costs should be seriously examined by scientists.

Mr. Chairman, I think that will end my testimony. And I would be happy to answer any questions, if I can.

[The prepared statement of Mr. Weber appears at the conclusion of the hearing.]

Mr. **Brown**. All right. Thank you.

I notice you cite Jamie Whitten's book, which I have not read yet, but I better read it because it will probably give me a clue as to what kind of help we can expect from him in certain of these research areas.

Mr. **Weber**. I think he made good suggestions in the book. I think it is interesting to see the series of environmental books which followed "Silent Spring," like "Before Silent Spring," and "Since Silent Spring."

I expect with the new introduction of biological techniques that sooner or later we will probably see a book entitled "Weird Winter; Strange Spring," if things happen as they have happened in the past.

Mr. **Brown**. You have not cited Aldo Leopold's "Sand County Almanac," have you, anywhere?

Mr. **Weber**. I don't believe I have.

Mr. **Brown**. I am fascinated by your statement, Dr. Weber. I don't think I have seen anyone who has had as lengthy a professional relationship to this question of pesticide impacts in any of the people who have appeared before the committee. You have been in this almost since the beginning of public concern about the area.

Mr. **Weber**. That is true, Mr. Chairman.

Mr. **Brown**. What has this done to your social and professional life? Have you managed to steer clear of——

Mr. **Weber**. Since I tend to be a bit outspoken, it probably kept me from the job which I have to do. But normally I have sympathy for both the environmentalists and agriculturalists, and I think if we had had a little more support in basic research in the 1960's, we probably wouldn't have needed a "Silent Spring" to stir us up and examine what we were doing with pesticides.

I think maybe this is still part of our problem. I see the old traditional agricultural areas restricting newer things, such as we have a strong consulting philosophy in agriculture because of our extension service that is sort of preventing some of us from contributing to other areas. For example, I know a great deal about organic toxicants, many of which are present in sewage sludge, being put on land. The engineers are consulting on these problems pretty commonly, and I would like to—I am sure I could contribute greatly, but I am being thwarted in my interests in that area.

Mr. **Brown**. Have you identified the source of your thwart?

Mr. Weber. Oh, yes. But I would rather not—I would rather leave him unnamed, if you don't mind.

Mr. Brown. I will not press it too much. I think you suffer a problem from trying to maintain an unbiased and objective scientific attitude in this area, and you make nobody happy in this process.

Mr. Weber. That is true. It has been that way really from the beginning. When I served on other committees in terms of ecology, and with other biologists, they tend to think of me as the industry pawn perhaps because I work with pesticides.

On the other hand, years ago when I first began to look at pesticides from the standpoint of their safety, the industry looked at me as some environmental nut. So I have had to do my best to objectively examine both sides of the coin. I think, strangely enough, we have come out of this very well. Even if people don't like what they hear, if ultimately it doesn't stop them from eating and it doesn't interfere with their life too severely, they should go on and just accept a little criticism and straighten out their situation. I think we have done that pretty well.

Mr. Brown. I have some problems with some of your statements, and I will mention a couple of them just to see how you react to it.

You have noted that the large-scale application of pesticides and insecticides, and so on, may have an effect on the microbial activity in soil. And you seem to come to the conclusion that this is not a serious effect. You say, in most instances the effects are transient and lasting a few days or few weeks. You do note the importance of soil microflora to the health of the soil in general.

Mr. Weber. Yes.

Mr. Brown. You say there is little evidence to show that pesticides have produced or are producing any long-range adverse effect on the many soil processes on which soil fertility depends.

I am not an expert in this field, but it has been said repeatedly before this subcommittee that we have an inadequate scientific knowledge of microbiological activity in soils. You are making a statement which seems to imply that we do have that knowledge.

Mr. Weber. Mr. Chairman, the only qualification I have is, I am basing it on the information that is presently out there. I certainly agree with you that we need a great deal more work done on microbiology.

Mr. Brown. You said that in your statement. I am reminded of the many statements that we have had over the period of considerable years now that chemicals such as EDB, for example, had no effect on soils. And then, all of a sudden, we banned it because we were finding that it was penetrating the water table; it was getting into drinking water; and it was getting into underground aquifers, and it had a very serious effect.

The original statement about EDB was made only because we didn't have enough information. I am questioning whether you have enough information to make the statement that you have made?

Mr. Weber. No, I don't. What we need to do is complete the environmental information on pesticides. As a matter of fact, about 5 years before Temik caused a problem in Long Island, I consulted with individuals about the matter and predicted that that was going to happen. And it happened. It was a situation where a compound was extremely water soluble, used in a soil with no colloids to bind it, and it moved and was persistent in underground waters. EDB falls into the same category.

This Handbook of Organic Chemicals that Karel Verschueren has put out has a great deal of information on organic chemicals and pesticides, EDB's and others. What we need is a similar package about pesticides that we could make the statement even more definite than I have.

We are going to continue running into problems of pesticides simply because I know of the water solubility of some herbicides used as sterilants, I know the rates and cases where they are used relatively in high amounts. Some work only by getting into the soil 5 or 10 feet. When they get that far in, they are bound to show up in water somewhere. So I would expect that we are going to continue to have individual problems.

But we are talking about literally tons of materials used on thousands of acres for the benefit of food production. Environmentally, I can say that they are about as safe as many of the other types of pharmaceuticals and medications we use.

We will certainly continue to have problems. We are certainly going to need to continue basic research to evaluate them, just as we are going to need the research to evaluate these new biotechnological changes that we are making.

I foresee the same thing happening with the new plant growth regulators and the chemicals that increase yields and shorten plants and have tremendous modifications of plants.

I think just listening yesterday and today on the philosophy of surpluses and food production and all, these new chemicals that are going to change plant growth patterns, flowering habits, amount of seed produced and all the rest, in conjunction with biological techniques—for example, genetic engineering and so on—are going to have a big effect on farm surpluses—certainly increase the yields to feed a lot of people.

But at what cost and risk? I certainly hope the USDA and Congress continue to support the basic research which I felt didn't have the support it needed for quite a few years.

Mr. **Brown**. The posture you have described is one which I think we take in this subcommittee. Some of us are a little more proenvironmental; some a little more proproduction-oriented. All of us have seen in these rapidly changing times new generations of technology in which invariably we were told the effects would be beneficial and not to worry; everything would be taken care of. And, just as invariably, we found we didn't have enough information to make that statement. Sometimes it was relatively simple information.

The case of EDB is not a complex research problem; it is a simple matter of not having sufficient monitoring capability or the foresight to anticipate certain mechanical things that would happen, you might say.

Mr. **Weber**. That is true.

Mr. **Brown**. The problem of some of these products of the new biotechnology are far more complex. And the problem of insecticides on the microbial activity in the soil is probably far more complex than the EDB type problem for which a great deal of research is needed before you can assert anything with any degree of certainty.

What we are trying to do, I think, is to get into a posture where we anticipate these things a little better than we have in the past, and have a knowledge base on which we can make policy judgments.

Mr. **Weber.** I would hope that we had learned something from "Silent Spring." But I am not sure.

I have the same apprehension that you do that we are advancing rapidly, being assured everything is rosy; but, on the other hand, I think the articles that I just mentioned here and the books, and Rachel Carson's book—she did her best to make the situation look much worse than it might have been, and she had a reason to do that. She wanted to catch our attention, and she did it very effectively.

Mr. **Brown.** That is the tendency of all popular publications. They have to be a little more emphatic than the facts justify in order to sell the books or the newspapers or magazines or television shows, or whatever it is. That is why we need more scientists having an input. Scientists never make those kinds of mistakes, you know.

Mr. **Weber.** Of course, not.

One comment to that: I think there are many, many scientists in the country who could make, and who would be willing to contribute opinions and information to governmental agencies much more so than they do. I know in our case, we had a PCB spill, and there were numerous scientists who could have contributed to that in how it could be handled. A lot of them just didn't want to volunteer because we have other things we like to do. But I am certain if any of our Congressmen had called them up and asked them, they would have been happy to contribute information to that problem.

Mr. **Brown.** I am sure that what you say is true, although there are occasions in which we find that there are problems arising because of a scientist's desire not to alienate certain powerful constituencies that maybe he is benefitting from. And the classic case we have of a few years back, in California, was the case of a major oil spill off the coast and we could find very few petroleum geologists who would be willing to engage in objective consultation with respect to the effects of a major oil spill. Their money came from the oil companies—not from public sources.

I know that this is an isolated instance, but it is something that we do have to be concerned about. And you have probably run into phenomena of that sort yourself.

Mr. **Weber.** I think so, because when Rachel Carson first appeared, I found that most of the agriculturalists had not read the book but they were adamant in saying she didn't know what she was talking about. Of course, I probably might not have read it except it was required in the course I took. And after I read it, I understood she was not particularly against pesticides—more against the way we used them, in the indiscriminate use of them rather than waiting until we really had a pest problem.

But I suggested that some of the industry who had some problems invite some ecologists and other consultants in to get some information, not because they wanted to hear what these people had to say but because they might be able to use the information that they had in their brains. In other words, you want some information whether it is good or bad. Sometimes you don't like to hear what you are about to hear; but if it is going to be of benefit to you, you better listen to it.

Mr. **Brown**. I have enjoyed very much your presentation, Dr. Weber. Your statement is certainly going to be very valuable to the committee. We appreciate your patience in remaining with us as long as you have, and we look forward to keeping in touch with you.

Mr. **Weber**. Thank you very much.

Mr. **Brown**. The subcommittee will be adjourned.

[Whereupon, at 4:10 p.m., the subcommittee adjourned, subject to the call of the Chair.]

[Material submitted for inclusion in the record follows:]

STATEMENT OF DR. H. ROALD LUND, DEAN AND DIRECTOR, COLLEGE OF AGRICULTURE, NORTH DAKOTA STATE UNIVERSITY

The Joint Council on Food and Agricultural Sciences was established in 1977 to encourage and coordinate research, extension and higher education activities in the food and agricultural sciences. This role was strengthened in the Agriculture and Food Act of 1981, which directed the Department to improve the planning and coordination of research, extension and higher education within the public and private sectors and to relate the federal budget process to the overall functioning of the system. The Joint Council is the only group which brings together high level administrative officers representing these various diverse segments of the research and education system for the purpose of planning and coordination.

One of the strengths of the U.S. food and agriculture research and education system is its diversity. This permits relatively rapid responses at local, state, regional and national levels to the varied problems facing food and fiber production, processing and distribution in the U.S. The diversity of the system occasionally leads to the perception that research and education are not coordinated. One role of the Joint Council is to facilitate coordination of various functions and performers. The Joint Council cannot dictate the activities of the performers, but it can provide and has provided leadership based on national priorities for food and fiber production.

National data bases for research, extension and higher education have been and are being established to provide benchmarks for activities in these areas. The current research information system (CRIS), a national data base of all research conducted by the State Agricultural Experiment

Stations and the Agricultural Research Service has been in existence since 1966. This system provides information on commodities, research problem areas, fields of science and whether the research is applied or fundamental. This system, accessible on line to agricultural researchers, provides a mechanism for coordination of research. The Cooperative Extension Service has recently begun a new accountability and evaluation system in which State Cooperative Extension Services submit four-year plans of work. The higher education system is making significant progress in delivering a national food and agriculture education information system. Data bases in research, extension and education are essential to monitor progress and to provide the information needed for a national overview as a guide for the budgeting procedure.

Recently the Joint Council office prepared two reports which will undoubtedly improve the overall effectiveness of the food and agricultural system. The first, the Needs Assessment Reference Document, is a 300-page report that contains 15 separate papers authored by 40 nationally prominent scientists and administrators, both state and federal. The second report, the Needs Assessment Summary Document, is a 75-page summary of the reference document, and has been distributed widely in the food and agriculture science and education System. An agricultural college dean in a neighboring state called this "the most clear, concise, complete statement on this subject I have seen" and further "it is packed with vital, easy to read, easy to understand information."

The annual priorities report of the Joint Council is prepared following receipt of inputs from the functional committeees (Research, Extension and Higher Education) and the Regional Councils. Priorities received from other sources (e.g. industry groups, professional societies, etc.) are provided to the National Committees and the Regional Councils and so are represented in the final priority setting activities. The FY 1986 priorities were established in a Joint Council meeting on April 26 and 27, and the Priorities Report will be published in August 1984.

A Five Year Plan has recently been completed by the Joint Council office. It is a conceptual plan derived from the problems identified in the long term needs assessment for food and agriculture. It lists, by subject matter categories, long range goals to solve those problems, short range objectives for ultimately attaining the goals, and present and projected resource allocation. The Five Year Plan provides a forum for continuing evaluation of the goals and objectives, a standard for evaluating progress, a planning aid for decision makers, and a accounting of resource allocation.

This plan will be widely distributed to administrators, scientists and educators and is expected to have an important impact on planning and activities within the system.

To describe the progress of the food and agricultural research, extension and higher education system, an annual accomplishments report is prepared. Examples of accomplishments are solicited from all of the participants in the system. Thus, on an annual basis, the Joint Council examines the progress and achievements on the various items described in the needs assessment and priority reports.

With continued and increased federal and state support of the science and education system, U.S. agriculture can continue to provide efficient food and fiber production for the populace and can provide our citizens with a safe and economical source of these essential items.

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STATEMENT OF JAMES NICHOLS, DEAN, COLLEGE OF AGRICULTURE AND LIFE SCIENCES, VIRGINIA POLYTECHNICAL INSTITUTE AND STATE UNIVERSITIES; CHAIRMAN, DIVISION OF AGRICULTURE, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES

Congressman Brown, Congressman Roberts and members of the subcommittee, it is a pleasure for me to appear today as the overall representative of our land-grant system. I would note for the record that several other official representatives of the system are scheduled including Dr. William Baumguardt, Director of the Indiana Agricultural Experiment Station, who was with you yesterday to represent our Biotechnology Committee. Dr. Neville Clarke, Director of the Texas Agricultural Experiment Station and Chairman of our Experiment Station Committee on Organization and Policy (ESCOP) joins me here today.

Dr. Henry Wadsworth, Director of the Indiana Extension Service and Chairman of our Extension Committee on Organization and Policy (ECOP) and Dr. John Brand, Director of Resident instruction at the University of Connecticut and Chairman of our Resident Instruction Commmitee on Policy (RICOP) will be with you next week.

Mr. Chairman, I wish to take this opportunity to thank you and the subcommittee for the valuable service your hearings represent. Unlike some investigations relating to agricultural science and education which had the answers before they started, your hearings have been open and objective. It is clear that you seek information for a better understanding in order to help the system meet our mutual food and agricultural challenges today and in the future. We greatly appreciate this attitude and this opportunity for comment.

I want to take just a few minutes to talk about the land-grant system and some misperceptions, I believe extist. I'll not dwell on program specifics because the other representatives of our system will do that.

The system is not a monolithic or homogeneous entity. Its' common denominator is the desire to make the maximum beneficial contribution to agriculture and our total society through research, public service, and education. The more than 70 institutions -- each with the multiple facets of research, extension and teaching -- are located in every state and the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa and Micronesia.

The American agricultural science system was a revolutionary concept. Practical and useful education for the masses, application of science to everyday problems and delivery of knowledge to people at the point of need were radical experiments. Today we accept the benefits with a casualness that emphasizes the success of the experiment.

Equally important, our system is evolutionary in nature. In each state the basic scientific foundation has adopted a unique personality to meet the agricultural needs of the state and region. The system reflects the diversity and complexity of the biological and climatic world of agriculture as well as upon relevant social and economic factors. We have over 250 "major" agricultural commodities. Each is confronted with a broad array of diseases, insects, and other stresses. Climatic variances within single states not to mention across the nation limit the use of single varieties and crops which makes location specific research necessary. Beyond that lies the complex uncertainties of economics, marketing, processing, domestic and foreign distributors and consumers demands.

No problem in agriculture is one dimensional. Each is multidisciplinary. The agricultural sciences of necessity stress multidisciplinary concepts. For instance, agronomy -- one of our most traditional agricultural sciences -- draws relevent aspects of the basic sciences of biology, physics and chemistry in forming a "science" to deal with the problems of crop production and soil management.

Our system is unique and probably could not be replicated today. The partnership between the Federal Government and States with a high level of local determination is unique. This structure does not meet the simple management concepts of business schools. However, the structure does meet the needs of agriculture and this nation. I claim this with no hesitancy because of our past performance.

The most obvious example of technological performance is the variety, quantity, and quality of our food supply. Just over two million farmers feed 235 million American and supply some 30 to 40 billion dollars of food items for export. The American people also enjoy the highest quality, most wholesome and lowest relative cost food supply in history. While, we are still concerned about food safety and quality, we are virtually free of the food borne diseases that still haunt most of the world. As a nation, we are free of the chronic problems of malnutrition.

I am not saying every problem is solved. However, I am saying we are now asking truly qualitative questions. We are asking how to make the best better. Tomatoes in a New York supermarket in January are not equal to that juicy, red tomato you pick from your garden in July. However, tomatoes are available 365 days a year. This is not a minor miracle. Our next step is to match the garden fresh quality.

After nearly two decades of what might be called benign neglect, our system was shocked by the intensity and variety of criticisms that have come over the past fifteen years. Some of the criticisms are just and some are not. However, I would stress they never fell on deaf ears. The system is constantly changing to meet problems and achieve better results. It is far different from what was in 1862, 1887, or 1914. In fact, it is different today from what it was in 1970. I honestly believe we have some of the best scientists in the world in our agricultural experiment stations. Further, the research allocation and review systems in the experiment stations are as tough as any. Extension programing is driven by clientele demands -- the toughest reviewers possible.

I appreciate the current interest in national priority setting. Clearly we should focus on the most important issues however, the concept must be handled in the context of the problems we face. I compared the FY 1985 Research Priorities for Research which was released this year with a somewhat parallel congressional document from 1948. It was revealing to note the major items in each were basically the same including economics, trade, soil and water conservation, human nutrition. Naturally, the specifics in the two are different. The point here, is the dynamic nature of agriculture makes planning in a specific way difficult, however, in a broader perspective it is reasonable, possible, and we do it.

The remarkable thing about the system is its strategic capacity to meet problems. The quickness with which we dealt with the Southern corn blight in the early 70's is a perfect example. I appreciate questions were raised about the narrowness of our genetic base. However, long before these questions were asked in the New York Times, our plant breeders were working to resolve the problem. Our germplasm collections, field based information systems, and close working relations with industry meet the challenge. If our resources had been greater we may have resolved the problem quicker but I want to point out the strategic importance of capacity and continuity. *Both* of which are inherent to our unique system.

Over the past year there has been a series of proactive studies, white papers, and reports. The legislatively mandated Needs Assessment by the Joint Council is the most prominent example. However, our system has conducted a review of each of our science functions. For Extension, a special joint committee of USDA and NASULGC examined the role and direction of Extension in the 80's. Our Experiment Stations in cooperation with USDA produced an outstanding report entitled *Research 84*. Finally, our Resident Instruction Section in cooperation with the total agriculture higher education community produced the white paper entitled *Human Capital Shortages: A Threat to American Agriculture*.

While we were no doubt defensive at times, I believe the system is responding admirably. I would like to express appreciation to your committee for the assistance you have given us in Title XIV of the 1977 and 1981 farm bills. I honestly believe our agricultural science system is in a position to respond to the challenges that face this nation and the world.

We need additional resources -- money, facilities, instruments and minds. We believe the declining share of Federal support for agricultural research and extension is unfortunate given the high social returns of such investments. Conservative estimates of the returns on agricultural research to society are 30% or more per year. In addition, there is an important equity question. The major beneficiaries of agricultural science investments are consumers. Further, the benefits spill over state lines. Both facts suggest a higher share of Federal support would be appropriate.

However, the system itself is sound. The complementary effect of our three functions result in a total product that exceeds the sum of the individual parts.

Resident Instruction, the first objective of a college, provides the trained scientists, technicians, entrepreneurs, and farmers to operate the food and agricultural system. The teaching program is enriched by its association with both research and extension. This association means agricultural teaching programs have the advantage of relevant, practical, and current problems of the industry in their curricula. This relevance is coupled with a vision of the future and a sound theoretical base that is at the very frontier of science.

The research program is the foundation of the system in that it provides the knowledge for the teaching program and the extension effort. Joint research teaching appointments permit faculty to stay on the cutting edge of their discipline. The research program also assures that graduate students have an opportunity to learn in a relevant environment where theory can be put to a meaningful test. The research program also helps attract graduate students to the teaching program.

The association of the experiment station with the land-grant university has another benefit of enhancing professional communication. Land-grant universities collectively represent the majority of the major research universities in the United States. Researchers in a given discipline at the university tend to communicate across arbitrary organizational lines. Thus, a biochemist working on animal nutrition in the experiment station may be collaborating with a colleague in the medical school who is working on human nutrition.

Extension represents the connective tissue that permits the research and instructional programs to realize their potentials. Extension extends the knowledge base of the university beyond the boundaries of the campus to the limits of the state. Further, extension is a two way communications system. It not only extends knowledge, it serves as the early warning system for researchers and the experiment station. Ideally, Extension will identify an emerging problem and advise the appropriate researchers. They will find a solution which extension takes back to persons facing the problem. All of this can occur without any major decisions by administrators at the state or federal level.

I am very proud of this system and its accomplishments. The creditable criticisms of the system, voiced over the past decade, have caused us to pause in our haste to solve immediate problems and again take inventory. We have learned and benefitted from this exercise. Your subcommittee has provided us with an important stimulus. We appreciate the constructive manner with which you have asked us to participate.

I am pleased to say we are ready, willing and able to work with Congress and the Executive Branch in meeting the problems before us and the exciting opportunities for American agriculture in the future.

STATEMENT OF
NEVILLE P. CLARKE
CHAIRMAN
EXPERIMENT STATION COMMITTEE ON ORGANIZATION AND POLICY

THE STATE AGRICULTURAL EXPERIMENT STATIONS IN TRANSITION

My name is Neville P. Clarke and I am the current Chairman of the Experiment Station Committee on Organization and Policy. I am also Director of the Texas Agricultural Experiment Station. I appreciate the opportunity to comment on agricultural research planning and policy as well as on emerging research opportunities in United States agriculture.

In February, 1984, the Experiment Station Committee on Organization and Policy in collaboration with the Cooperative State Research Service of the U. S. Department of Agriculture published a document, entitled "Research 1984: The State Agricultural Experiment Stations," which provides a contemporary view of the State Agricultural Experiment Stations. This publication reviews the structure, performance, and funding of U. S. agricultural research and identifies specific opportunities and challenges for the U. S. research system. An outline of the system's planning process, including issues and priority setting, is also contained in the booklet. It is through this ongoing process that a research agenda continues to develop for the State Agricultural Experiment Stations. I shall draw substantially from this document in the testimony given today and I recommend it for consideration by the members of the Committee and their staff. The publication has been made available to each of the members.

The State Agricultural Experiment Stations are a part of the broad national system of agricultural research which includes research activities in other parts of the Land-Grant Universities, the non-Land-Grant Universities, the United States Department of Agriculture (in federal laboratories), and the private sector. The state-federal partnership existing between the USDA and the land-grant institutions is well known. The role of the State Agricultural Experiment Stations has been reviewed and evaluated a number of times in recent years; this role has been the subject of testimony before this committee. Suffice it to say here, the State Agricultural Experiment Stations are responsible for a major component of the total program of national agricultural research.

A key concept relating to the planning and funding of research in the State Agricultural Experiment Stations is the continuing need to maintain a broad, dynamic and vigorous base program of research. This base program must address the problems related to the numerous agricultural commodities produced in this country. Operation and management of the base program must incorporate the growing concern for effective utilization of natural resources, the geographic specificities of agriculture in the United States, and the ongoing need to bring together several scientific disciplines to provide problem-solving research on contemporary issues. The intersection of commodity orientation, geographic location and disciplinary approach provide structure and dimension to a highly distributed system of agricultural research. The base programs of research in the State Agricultural Experiment Stations develop and adapt within this structure and exhibit the following characteristics:

1. They are a decentralized but contain a regionally and nationally coordinated set of research objectives.

2. They are dynamic, undergoing continual modification in response to short term and long term needs.
3. They are funded predominately from state appropriations and other local resources.
4. They are dependent upon federal funding not only for support of research, but to facilitate communication and effect overall planning of research.
5. They are balanced with fundamental programs supporting site - and commodity - specific activities.
6. They provide early problem recognition and rapid response to critical issues and problems through close coupling to clientele and feedback from the Agricultural Extension Service.
7. They conduct research identified and planned from the grass roots up involving input from the producer, the consumer, and the scientist.
8. They provide a capacity to identify problems and capture new opportunities. Response may be singular and local or may entail forwarding through the system issues aggregated at the national level.

This testimony has been entitled "The State Agricultural Experiment Stations in Transition;" I would like now to address this topic and I will return to it several times during my presentation to make specific points. The State Agricultural Experiment Stations are constantly involved in transition because of the nature of the problems being addressed, evolving scientific expertise, and changing resource allocation. There is a crucial need to maintain stability in long term research activities in the State Agricultural Experiment Stations and throughout the national system for agricultural research. This stability should not be perceived as a lack of innovation; instead, it should be recognized as reflecting the nature of research. However, it must also be recognized that in the opinion of most people who have evaluated the system, the State Agricultural Experiment Stations will undergo some very substantial changes in the next fifteen years.

There are a number of motivations, both external and internal, activating change in the State Agricultural Experiment Stations. Externally, financial constraints, natural resource limitations and environmental concerns are exerting considerable pressure on contemporary agricultural production. Internally, exciting new technologies are providing dramatic opportunities, particularly in the basic sciences, to develop long term solutions to difficult problems in agriculture. The experiment stations, both through internal and external evaluation, have charted proactive rather than reactive courses and are moving forward vigorously to take advantage of these new opportunities. There has never been a time in the history of our country in which opportunity and problem have met in such a propitious manner.

The continuing transition of the State Agricultural Experiment Stations, is also motivated by broad critical issues, more pervasive than the needs of any one state or region, which are aggregated for consideration at the national level. A thorough description of these issues would be beyond the scope of this testimony, but several of the most critical can be listed, by conceptual definition, as follows:

1. **Macro-economic factors including the overall economic outlook of the country, international trade, interest rates and availability of capital.** Such factors are not solely related to agriculture but are related to the broad macro-economic situation of the nation. While agricultural research may not be capable of drastically modifying the macro-economic environment, such research must deal with the effect that this environment has upon production agriculture and agribusiness in this country.
2. **Limitations in exploiting natural resources.** Major new research is needed to address the development of technology that allows for better use of limited resources and that targets the conservation of irreplaceable critical resources, particularly our nation's agriculturally productive soils.
3. **Diverse and expanding agricultural clientele.** Research supporting changing clientele, both the new generation of small, part-time farmers, as well as the larger elements of production agriculture, must be considered in a more interactive and dynamic way. The size-neutrality of agricultural research is an area requiring continual reevaluation to assure that the total resource is equitably applied among the elements of agriculture and agricultural production.

4. **Current surpluses versus long term demand.** It is important to recognize that the surplus situation is transient in nature and that with relatively small variations in climatic conditions on a world-wide basis, present excesses can be replaced by major shortages of food. In the long run, the capability to produce food and fiber will be essential to meet the demands of an enlarging world population. Much of the research underway today is directed not towards production but towards conservative use of natural resources and other inputs - towards more efficient production rather than increased quantity of food and fiber. Ultimately, this will allow more profitable agriculture and provide inherent capacity for enhanced total food production. Some governmental regulation of total quantity of food produced during the continuing emergence of new technology may be necessary to balance supply and demand in the short run.
5. **Concern for food quality and food safety.** There are broad implications for the food and fiber supply of this country regarding production techniques, the use of chemicals, and processing and marketing methods. New research is required to increase the confidence of the consumer in both the quality and safety of food and fiber.
6. **The growing concern for environment quality.** The production of agricultural products has associated with it the potential for soil, water and airborne pollution. Increased use of conservation tillage methods to conserve energy also offer

potential problems with increased pesticide use. Research is needed to evaluate the effects of pesticides on the biota that make up the ecological system in soils, on soil structure, and ultimately on water supplies. Accelerated programs should be implemented to seek alternative methods for insect and weed control including affordable biocontrol methodologies.

In the document "Research 1984: The State Agricultural Experiment Stations," a series of priority opportunities for agricultural research has been identified. Expanded research on these new priority opportunities would address the need identified by Congressman Brown in his testimony on this subject last year. He said at that time, "we [nation, congress, research system] have emphasized applying existing knowledge and have failed to replenish our intellectual capital." The areas of priority opportunities include:

1. Biotechnology
2. Electronic Technology
3. Natural Resources
4. Food
5. Environment
6. Agricultural Policy and Foreign Trade

There is good evidence to say that the need for additional research to support agriculture in the United States is profound. There is also clear indication of existing opportunity in exploiting emerging areas of science to address the needs of agriculture. What I believe must be identified now are the factors that will enable continuing transition within State Agricultural Experiment Stations and provide capacity to exploit available opportunities. The factors enabling change in the agricultural system include the following:

1. **A strong base program.** The existing infrastructure of the land-grant institutions and the State Agricultural Experiment Stations offers advantages in capturing new initiatives emerging from the base program of research. It is essential to maintain the health and vigor and the dynamic nature of this base program broadly distributed throughout each of the states.
2. **Resources for people and equipment**: Of the several opportunities that have been identified by the State Agricultural Experiment Stations as being relevant and ready for action, biotechnology has received the broadest support and addresses the opportunities in basic biology most explicitly. The biotechnology initiative was proposed through the experiment station community for funding by the USDA at a level of approximately $70 million. The Administration's budget proposed to have $28.5 million of this total of $70 million per year provided in the FY85 budget. Yesterday, Dr. Bill Baumgart, a member of the Biotechnology Committee of the Division of Agriculture of the National Association of State Universities and Land-Grant Colleges discussed in detail this initiative. His testimony covered opportunities, program mechanics, resources, and methods to assure accountability.

The land-grant community has fully supported the Administration's recommendation for FY85 and is proposing to the USDA that continued growth of the biotechnology initiative be advocated for FY86. The recent markup by the House Appropriations Committee for the Cooperative State Research Service and related USDA programs does not react favorably to the proposal of the Administration for the biotechnology initiative. Perhaps additional communication about the relevance and importance of this opportunity and the critical nature of timing needs to be undertaken by the land-grant community to convince members of the Congress of the need for a more positive decision. As conveyed by Dr. Baumgart yesterday, the research system most urgently needs to exploit the existing opportunity in biotechnology today and the competitive grants program suggested for the biotechnology initiative would be an effective use of new resources.

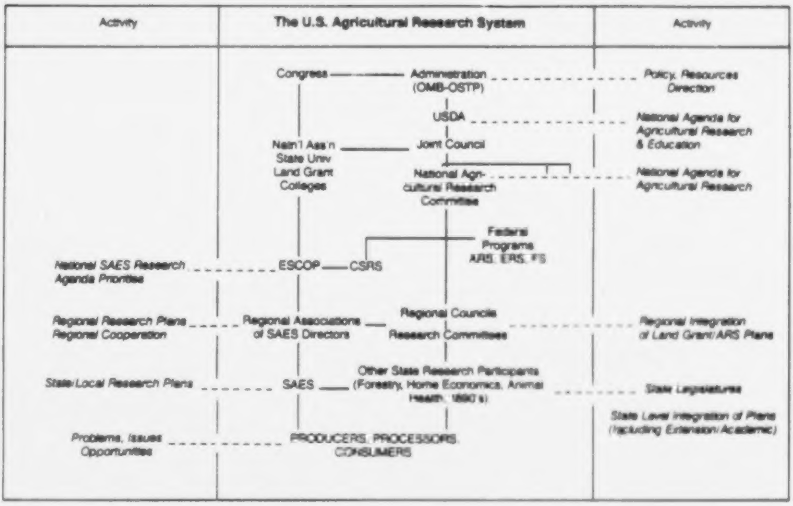
The scientific personnel necessary to exploit opportunities in biotechnology are already scarce and will become even more difficult to find in the several years that lie ahead. A recent survey of land-grant institutions indicates substantial turnover in scientific personnel over the next several years. Replacements produced in graduate programs will not uniformly resupply the areas of need and will certainly not provide the kind of talent necessary in biotechnology in agriculture. It is very urgent that, as part of the total resource package, we consider funding for the training of new scientists.

The biotechnology initiative as has been proposed in the Administration's 1985 budget does not specifically identify the training of scientific manpower as an objective. However, it is quite clear that this proposal will provide major opportunities for graduate student education in the laboratories where such research will be conducted. This adds increasing impetus to the need for the biotechnology initiative in FY85 and in the next several years.

3. **Involvement of broader segments of the scientific community in agricultural research.** We need to broaden the scope of the total scientific involvement in agricultural applications to include the elements of the scientific population that are not imminently related to agriculture but which could be focused to address some of the basic research problems.
4. **Development of inter-disciplinary strategies.** In looking at the factors enabling change, it appears critical to develop a strategy that will create incentives for inter-disciplinary research in order to create teams of people, rather than individual scientists, to exploit the opportunities in basic biology.
5. **Planning and Priorities.** The Congress, as well as other elements of government, have continued to review the planning process for agricultural research at the national level;

these studies have provided relatively good concensus as to the nature of the present process and to the opportunities for improvement. Generally, it is apparent that major changes are unnecessary in a system which is perceived by most studies as functioning relatively well. A key to developing a total program of research at the national level is recognizing the highly distributed structure of the system in the states and the relationship between this system and federal research activity. The distributed system and the methods used to meet the needs of local geographic and commodity issues is a source of continuing strength derived from the basic precepts of the land-grant system. Intertwined with these processes at local and state levels are activities on regfonal and national levels; these activities allow the aggregation of commonly perceived needs. A perspective emerges of pervasive issues and common needs for consideration of decision makers at the national level.

The document entitled "Research 1984: The State Agricultural Experiment Stations," includes a flow-chart which shows the nature of the planning process and identifies the priority setting process at the state and local level. This process provides early recognition of problems and allows research managers to redirect resources to meet immediate needs. In


Activity
The U.S. Agricultural Research System
Activity
Congress
Administration (OMB-OSTP)
Policy, Resources Direction
USDA
National Agenda for Agricultural Research & Education
Natn'l Ass'n State Univ Land Grant Colleges
Joint Council
National Agricultural Research Committee
National Agenda for Agricultural Research
Federal Programs ARS, ERS, FS
National SAES Research Agenda Priorities
ESCOP
CSRS
Regional Research Plans Regional Cooperation
Regional Associations of SAES Directors
Regional Councils
Research Committees
Regional Integration of Land Grant/ARS Plans
State/Local Research Plans
SAES
Other State Research Participants (Forestry, Home Economics, Animal Health, 1890's)
State Legislatures
State Level Integration of Plans (Including Extension/Academic)
Problems, Issues Opportunities
PRODUCERS, PROCESSORS, CONSUMERS

addition, the process provides a capability to communicate at the grass roots level, with the users and beneficiaries of agricultural research.

For the State Agricultural Experiment Stations, an important transitional phenomenon that is occurring in national planning is the emergence of the Joint Council as an effective and meaningful voice. Priorities identified at the state and regional level are submitted to the Joint Council; these can be readily seen in the excellent documentation on need assessments and new initiatives. This Joint Council activity demonstrates a major revitalization of the planning process at the national level and has the desired effect of dealing with broad pervasive issues rather than with the details of individual research programs.

The Subcommittee wishes to address the implications of overproduction in agriculture on the scope and content of future agricultural research. As previously mentioned in this testimony, overproduction is viewed by most policy thinkers as a transient occurrence. Certainly, agricultural research in the decades ahead will need to factor in concern for overproduction, but, clear sight of the fact that world food production will have to be increased substantially to meet projected demand must not be lost. Increasing the effective use of natural resources and other inputs for production agriculture will have the effect of stabilizing production yields; this same technology can be used to increase supplies when warranted. As has been indicated by the staff of this committee, a balance between production, conservation of resources and maintenance of a quality environment, are all necessary aspects of planning at the state, regional and national levels.

Farm structure has undergone continuous change during the development of modern agriculture in the United States. Most people who deal in agricultural policy believe that structural changes will continue in this sector; disagreement arises over the rate of such change. In many states, there is emerging a new brand of small farmer or rancher who earns his living primarily in the urban environment and lives in the rural environment as a matter of choice. These individuals utilize agricultural resources and will demand, as taxpayers, that their needs and interests be fulfilled through agricultural research and extension. The system needs to make maximum use of the total resource embodied in this new generation of rural dwellers and assure that resources are invested in the most productive manner. There will also continue to be, in most people's view, the presence and need for large scale agricultural enterprise in the United States.

Successful management of all agricultural operations will require sophisticated decision aids to economically produce large quantities of food and fiber. Because of the technical complexity in modern agricultural operations, the growing need for producers to understand and employ risk management, marketing strategies, and complex evaluation of economic return, there has emerged a very urgent need to provide decision aids. The computer, increasingly available at lower cost, offers some exciting new opportunities to provide the kind of service that is needed. The State Agricultural Experiment Stations are deeply involved in adapting existing hardware and existing capabilities for software development in a way that meets local and regional agricultural needs. As attention is directed to the development of decision aids for agriculture, more pressure is placed on the basic biological and economic programs of research in the State Agricultural Experiment Stations. A close relationship has emerged between research and extension communities in the land-grant institutions to assure that early development of models and other decision aids from research are successfully transitioned to "user friendly" software and delivered to agricultural producers. In the decade ahead, it should be possible to provide current and very meaningful decision aids to all elements of agriculture on a very cost-effective basis.

The transition in agriculture, particularly as regards the process of more effective planning and setting of priorities, has been exemplified by the development of an explicit Six-Year Plan by the Agricultural Research Service and by documentation developed by the Joint Council. The State Agricultural Experiment Stations sense a need to clearly enunciate their perception of the national agricultural research agenda for input into the Joint Council planning process. The Experiment Stations Committee on Organization and Policy is presently reviewing the methodology that will allow this communication and planning to occur within the experiment station community.

An action agenda which has emerged from these early efforts to more clearly state the State Agricultural Experiment Stations thinking on research needs is contained in the document "Research 1984: The State Agricultural Experiment Stations." In this agenda major emphasis and highest priority is placed on nurturing and expanding the base programs of research. In addition to maintaining the viability of the base program there is also need to capture the specific new initiatives that I have mentioned earlier in this testimony.

The priority opportunities identified in the State Agricultural Experiment Station research agenda are:

Biotechnology - Research is moving the agricultural production system towards a new science based on the capacity to manipulate and modify plants and animals, using recombinant DNA and other new technology.

Electronic Technology - Rapidly developing electronic technologies are adding capacity and new capabilities to modern research. The incorporation of computer technology in agricultural production also offers significant new management and communications tools.

Natural Resources - New technologies, incentives and production systems must be devised to increase efficiency of resource use and encourage conservation of natural resources.

Food - Safe and wholesome foodstuffs are major national concerns. Improved production practices, new storage and preservation techniques, and thorough understanding of nutrition are pressing research needs.

Environment - Substantial need exists for full ecological understanding of agricultural production system components and increased awareness of social implications in technology development.

Agricultural Policy and Foreign Trade - Maintenance of strategic agricultural strength requires a federal policy which links the economic strength of agriculture, production efficiency, with the best potential markets, export sales.

I would like to conclude my testimony by summarizing and reiterating four points considered by the Experiment Station Committee on Organization and Policy as key aspects of any deliberations on the American agricultural research system.

1. The broad base programs of the State Agricultural Experiment Stations form a continuing strong national resource. These programs are dynamic, responsive, and successful. The base programs provide an infrastructure upon which to implement new initiatives that will address the critical issues facing agriculture in the future.
2. The decentralized system of national agricultural research in this country represents a strength, not a weakness. Planning should be encouraged at the grass roots level and the capability of the system to aggregate isses for priority-setting and funding strategies should be recognized. There is very strong benefit associated with agricultural research; a benefit which far exceeds the cost. While overproduction of food remains a possibility, agricultural research should

be viewed as the glue maintaining an infrastructure providing for short term solutions to economic problems and long-range cures to world food demand.

3. A substantial metamorphosis of the State Agricultural Experiment Stations is underway. The system is retaining the strength associated with a distributed decision-making process and addressing the needs of agriculture on a local and regional basis. It is doing an effective job of coalescing pervasive issues so they can be considered for the allocation of limited but important new resources. The ability of the existing and emerging systems of planning for the national programs of agricultural research appear to be going in the right direction. This process can be characterized as maintaining a sharp focus on specific issues at the local level yet retaining a crisp identification of pervasive issues at the national level.
4. Finally, as the federal system must inevitably deal with the question of total available resources, we fully recognize that there is need for continuing inquiry into the nature of agricultural research and the value of overall payoff. We believe the economic assessment and critical pathway analysis that has been identified as being crucial for agricultural research is done explicitly and in substantial detail at the state level. As the process begins to aggregate more general pervasive issues, the use of the critical pathway technique becomes more difficult because of the broad implications that

are related to any single national issue that is raised. Nonetheless, it is the expectation of the State Agricultural Experiment Station system that increasing efficiency can be placed in the analysis that leads to the distribution of resources to support broad national initiatives in agricultural research.

Thank you for the opportunity to speak to you today about agricultural research planning and policy and agricultural research opportunities.

Meeting Future Needs for U.S. Food, Fiber, and Forest Products

Kenneth R. Farrell, Director[*]
National Center for Food and Agricultural Policy
Resources for the Future

Mr. Chairman, I welcome this opportunity to discuss implications of the RFF report, "Meeting Future Needs for U.S. Food, Fiber, and Forest Products." The report was prepared in 1983 under contract with the U.S. Department of Agriculture as part of the Needs Assessment conducted by the Joint Council on Food and Agricultural Sciences. The report is included in its entirety in the Joint Council Reference Document: Needs Assessment for the Food and Agricultural Sciences, January, 1984.

My statement is limited to two aspects of the report - (1) methodology and reliability of projections, (2) major inclusions and implications for long term research and education planning - and some observations concerning the usefulness of economic projections and "critical path analysis" in research planning and priority setting.

1. Methodology and Reliability of Projections

The RFF report was designed to provide insights into two major questions: (1) what are likely levels of effective (commercial) demand for U.S. food, fiber, and forest products by the years 2000 and 2020?, (2) what are the likely capabilities of the United States to respond to such demands?

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[*] Statement at hearing of the U.S. House of Representatives, Committee on Agriculture, Subcommittee on Department Operations, Research, and Foreign Agriculture, Washington, D.C., June 7, 1984. The views expressed are solely those of the author and in no way constitute a statement of policy of Resources for the Future.

In approaching the first question, it was necessary to assess not only demand prospects for food, fiber, and forest products in the United States but also demand, and supply prospects for such commodities in other regions of the world as a means of assessing potential export demand for U.S. commodities. Conceptually, effective (commercial) demand was treated as being determined by these factors: population, consumer income, and national policies which not only affect population and income growth but govern or strongly influence the price of food, fiber, and forest products and their availability through trade.

The supply of food also was viewed as being a function of three factors: the land area and other natural resources devoted to crops, livestock and forestry production and the quality of those resources; available technology and the resulting crop, livestock, and forest product yields; and national policies which affect resource development, research and technology, availability of production requisites, and the economic incentives for farmers to invest in the production of food and fiber.

This basic conceptual model was systematically applied to the countries of the world grouped into 12 regions on the basis of geographical proximity and similarity of economic systems (i.e., whether market or centrally planned economies). Commodities were treated in major groupings, including cereal grains, oilseeds, fibers, and livestock products of meat and milk. The study focuses on food and fiber consumption (effective demand) rather than requirements. The difference is important because projections of consumption take into account the constraints imposed by economic and physical conditions, constraints that are important everywhere, but especially in the poorest regions. Assumptions were that domestic demand will be satisfied first by domestic production, any surplus will be exported, and any deficit will be met by imports.

The analytical approach involved a detailed examination of the relevant trends of recent decades, with emphasis on population income, food consumption patterns and consumption policies, financial conditions (trade,, payments, foreign exchange balances, and debt), land development and availability, land use, mechanization, fertilizer use, crop and livestock yields, and production policies. The purpose was to understand the forces causing those trends to develop as they did. In the next step, major trends were projected into the future to ascertain long-term patterns of production, consumption, and trade. The process involved detailed consideration of whether projected trends might be expected to pertain in the future, and if so, what the most plausible outcome at various times in the future might be.

This approach was applied to each region individually, and then the results aggregated to obtain global totals. If the results of an initial iteration proved implausible, the likely causes were identified and the projections modified. This process was continued until a plausible, consistent set of regional and aggregate projections resulted. The comparison of the projections of apparent consumption with the quantities supplied (production) indicated the extent of imbalance and the implied world trade.

The study did not explicitly project prices. In the short run, prices were assumed to change in accord with relative changes in supply and demand of commodities in the various regions. This implies a trend toward higher prices in those regions where food deficits were projected to increase.

Overall, and for the 20-year period as a whole, real prices on a global basis are assumed to approximate those of 1979-1981.

The study involved analysts' evaluation and judgment of future developments, especially regarding policies and their impacts. Such judgments attempted to incorporate frequently disparate information deemed relevant to forces driving the important trends. Study of previous policies and their apparent success or failure provided a basis for assessing whether they are likely to be continued into the future or be substantially modified and in what fashion.

With respect to the assessment of U.S. long-term productive capabilities for food, fiber, and forest products, we draw extensively upon numerous reports concerning the current and prospective availability of natural resources and other production inputs, current and prospective production technologies, and long-term trends in resource use and yields of major crops. In many respects, this phase of the project consisted of a synthesis of current information and knowledge about the agricultural and forestry sectors. Three crop yield scenarios were developed (static yields, adjusted trend yields, and "high-tech" yields) and explored with respect to implications for resource use, environmental quality, and economic variables.

I cannot stress too strongly that the results of our assessment are not predictions or forecasts of what will happen. The future remains uncertain and unpredictable for mere mortals! Our projections can best be viewed as central tendencies of future change - a general path of change - based on trends of the past adjusted by our best judgment of their applicability in the future and realization of key assumptions which undergird changes in demand, supply, and trade.

Numerous assumptions, plausible assumptions from our perspectives, were involved at every stage of our assessment. Among the most critical were:

- Population: generally population growth rates are those of the World Bank which provide for declining rates of growth on a global basis and in most regions of the world into the 21st century. These rates may nonetheless underestimate the rate of decline based upon recent U.N. data. Because of the large absolute population levels we are dealing with, even a modest variance in the growth rate would yield a large numerical change in population, e.g., a change of .05 percentage points results in a change of 65 million in population.

- Economic Growth: we assume substantially slower total and per capita economic growth on a global basis for next decade or two than in the 1970s. Here too, small changes in growth rates from those assumed could have significant impact on effective demand for some commodities, e.g., a .05 percent change in per capita economic growth could change demand for meat by nearly 8 percent from that we have projected.

- Consumption Patterns: we have assumed that consumption patterns will continue to be influenced by changes in income largely as in the recent past. Although we have attempted to reflect ongoing changes in diet, it is possible that actual consumption patterns will deviate substantially from those projected depending upon changes in income distribution, the stage of economic development, and changes in knowledge concerning nutrition.

- Availability and Prices of U.S. Production Inputs: we assumed that supplies of commercial production inputs as a whole will be readily available at prices increasing at about the same rate as general price level increases in the economy - i.e., at stable real prices. But energy prices are tenuous and potentially volatile.

Given these caveats, it is clear that the "reliability" of our projections hinges importantly on whether our critical assumptions are realized. Other analysts might have adopted different assumptions and accordingly reached different conclusions. As a forecast of what will be, our results are obviously subject to very wide "confidence limits." It is important not to claim or expect too much of our conditional projections. There can be no assurance that the developments based on past experience which undergird our projections will extend into the unstable, uncertain future. Indeed, it seems likely that some such trends will not persist as new constraints and opportunities emerge. But the precise "turning points" of secular trends and relationships cannot be predicted, and projections to some distant point in time reveal little of the year-to-year events along the path of development. Unpredictable discontinuities induced by actions of humans and nature may cause performance to swing widely for short periods around secular trends. Such possibilities are proportional to the time horizon being considered.

The foregoing caveats are not to suggest that the future must merely "happen." The uncertainties which pervade the future and our inability to forecast it should not be cause for failure to take present actions to shape the future. The analysis, judgments, and conclusions in our report are intended to be useful for discussion and for decisionmaking by those in position to influence the future by present and future actions. But they are without clairvoyance.

2. Major Conclusions and Implications

Our report contains a six page summary of conclusions and implications. From those conclusions, I single out which we believe have the greatest implications for science and education planning and priorities.

1. Although the U.S. agricultural and forestry sectors appear to have the potential capability to meet projected growth in demand to the year 2000 at real prices approximating those of 1979-81 without new major breakthroughs in technology, the longer term prospects are more formidable. By 2020, production of major crops may need to be increased 70-100 percent. Without continued growth in productivity from technologies yielded by

research, there would be increased pressure, perhaps inordinate pressure, on the natural resource base, increasingly serious environmental problems, and ultimately, higher real costs of food, fiber, and forest products. Given the long gestation period for many types of research, a steady stream of investment will be required in the course of the next two decades to meet those long-term needs.

2. The growth in demand for U.S. products is likely to be highly unstable around the central path of development we have projected. Although U.S. productive capacity appears adequate to meet demand on average over the next decade or two even with existing technology, it is important to continue to invest in productivity-enhancing research as a means of maintaining competitiveness in world markets and as a contingency against the unexpected and the unpredictable vagaries of weather and public policies at home and abroad.

3. Expansion of productive capacity to the 21st century will not be without its costs and hazards. Expansion by more extensive use of land and water resources may bring not only higher economic costs of the resources themselves but risks of further environmental degradation through soil erosion and water pollution. But expansion of productive capacity by more intensive use of current high technologies also will have costs and pose hazards to the environment and the food chain. A shift toward greater dependence on cash crops and increased use of chemicals could enhance such hazards.

4. Future public investments in agricultural and forestry research should be based on more than generating technology per se or a simple multiplication of product output. Emphasis will be needed on the development of socially appropriate technologies that take into account not

only agricultural and forest product needs but also national goals concerning environmental quality, natural resource conservation, human health and nutrition, and other sometimes competing social goals. In addition to investments in the physical and biological sciences, investments will be needed in institutions which govern the use of technology, in human development, and in social science research to improve understanding of human and institutional behavior.

5. To attain the stream of appropriate technologies and institutions needed for the 21st century will require purposefully designed science and education policies and strategies predicated not on the circumstances of the moment but on perceptions of the needs in a distant, uncertain future. It is estimated that to meet demand for food, fiber, and forest products approximating that projected in this study for 2020, public funding of research will need to be increased at a compound annual rate of 10 percent between 1983 and 1994, with funding between 1994 and 2020 maintained at the real investment level of 1994 and as a constant proportion of the value of agricultural and forestry output over the 40 years.

3. Long-Term Projections, Research Planning and Priorities

One of the questions posed in your memorandum announcing these hearings was how such projections as those just summarized might be used in establishing research priorities.

As already noted, long-term projections should not be regarded as long-term forecasts. There is nothing unevitable about the outcomes of any set of projections. At best, such projections within the limits of assumptions, methods, and judgment of analysts can suggest general "pressure points" which might develop in the system. In that sense projections may be useful to research planners in formulating long range strategies to avoid or alleviate such pressures. For examples, our projections suggest that U.S. agriculture will become increasingly cash crop and export dependent in the next 20 years. Soybeans and feed grains, particularly corn, are likely to experience the most rapid rates of demand growth. That development portends expansion of cultivated acreage for those crops in Midwestern, Delta, and Delta states by withdrawal of land from pasture, double cropping, and expansion of cultivation on marginal land. It also implies more intensive cultivation using high-tech methods. In combination, such adjustments suggest the likelihood of increased soil erosion and environmental problems in the absence of new technologies and management regimes. Such possibilities suggest the need for research to counter such tendencies.

Water seems likely to become increasingly costly in the decades ahead with consequent economic effects on regional production patterns. Research in technologies to improve water-use efficiency and institutions to encourage rational allocation of water among competing uses would seem to be of high priority for agriculture at least in the Western part of the country.

If as suggested in our report, export markets are likely to be the "flywheel" of future growth in agriculture, research to assist in identifying export market opportunities, adapting product characteristics to requirements of foreign markets, improving the efficiency of export product delivery systems, and in the design of new or improved "value-added" products may be of high priority. It is obvious, however, that research by itself may be insufficient to resolve potential problems or achieve desired public goals for agriculture. Other types of policy adjustments may need to accompany research and development to encourage appropriate resource use adjustments.

Perhaps the single most important implication of our projections for research planning is the need for continued investment in productivity-enhancing technology to meet long-term, unstable, and uncertain world demand. But such technology should be compatible with long-term public goals concerning natural resources and quality of the natural environment. Technology affects people and institutions in different, uneven ways. Thus, if society gains from investment in agricultural research as indicated in many studies, we should be concerned about how those gains are distributed and with institutions and policies to assist losers in adjusting to changes induced by technology.

TESTIMONY OF MICHAEL J. PHILLIPS, PH.D.
PROJECT DIRECTOR, FOOD AND RENEWABLE RESOURCES PROGRAM
OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS
BEFORE THE
SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND FOREIGN AGRICULTURE
OF THE HOUSE COMMITTEE ON AGRICULTURE

ISSUES IN FOOD AND AGRICULTURAL RESEARCH

JUNE 7, 1984

Mr. Chairman and Members of the Committee:

Thank you for inviting the Office of Technology Assessment to appear before you today. I am Dr. Michael Phillips, the Project Director of OTA assessments that have focused on agricultural research and currently the director of the assessment "Technology, Public Policy, and the Changing Structure of American Agriculture." My purpose today is to comment on those items in your Charter for these hearings where OTA, through its past and ongoing studies, can contribute.

1. Impact of the Needs Assessment Study

For the past year, I have had the pleasure of being invited by the Joint Council and its staff to be a part of the process of determining the long-term needs for food, fiber, and forest products and of determining the research required to meet the identified needs. This has been a long and arduous task for the Joint Council. The Council and its staff are to be commended for the document Needs Assessment for the Food and Agricultural Sciences that for the first time represents a broad consensus of the agricultural research community on the most urgent needs in the food and agricultural area. However, I hasten to add that the document is too general to be used as a planning document for specific research topics. Perhaps the Joint Council 5-year plan and the annual Priorities and Accomplishments reports required by the Food and Agriculture Act of 1981 will provide this specificity. Every effort needs to be made to have these reports reflect the priorities of the long-term Needs Assessment.

The Agricultural Research Service released its long-range plan in February 1983. It is difficult to compare the ARS plan with the Needs Assessment, since the latter is concerned with the whole research system and the former with only one part of the system. However, the general findings in both reports are not in conflict. As the Joint Council completes its work on the 5-year plan and the annual Priorities and Accomplishments reports, a more accurate comparison then can be made with the ARS plan.

The Charter for these hearings asked whether or not the Joint Council and Users Advisory Board should be involved with establishing more detailed priorities. Such a task is more appropriate for research administrators and scientists. The Joint Council and Users Advisory Board can better provide guidance on how overall priorities may need to be adjusted to meet the most pressing needs.

The Charter asks whether a greater use of economic analysis is needed in setting priorities. Economics is being used more to determine if a problem is significant. A number of leading economists were used in preparing the Needs Assessment. However, the economics discipline as well as other disciplines, such as sociology, engineering, life sciences, and others, are not used to a great extent in determining if the technology selected to address the problem is expected to have a socially desirable outcome.

2. Ramifications of Supply/Demand Projections

Supply/demand projections for the next 15-20 years indicate that export trade will be increasingly important for American farmers. Most observers, however, agree that the tremendous surge in U.S. agricultural exports witnessed during the 1970's is not likely to be repeated. However, that does not mean that research to increase productivity--i.e., the ratio of output per unit to total input--should be any less important. To be competitive in world markets will require significant increases in productivity. However, a productivity measure does not include such factors as environmental, social, or structural impacts of technologies. It is hoped that increased productivity is compatible with long-term sustainable production.

One of the potentially largest payoffs in the food and agricultural export market is for high-value, processed farm products. World trade in high-value farm products grew fast enough over the 1970's to surpass the trade in bulk farm products that traditionally dominated world trade. The U.S. has been hard-pressed to compete in the high-value world food market. Technologies to increase productivity in the postharvest sector could contribute significantly to establishing the U.S. as a major competitor in this market. In fact, many of the opportunities for advances in postharvest capability may be "high tech" and might be most opportune for the U.S. However, as I testified in this Subcommittee's hearings last year on agricultural research, postharvest technology research has been neglected for many years. With the emergence of the high-value export market, there is all the more reason to evaluate resources allocated to this sector. It should be noted that in its 6-year implementation plan, the Agricultural Research Service plans to devote more resources to the postharvest sector.

3. Technology and Farm Structure

A great deal of interest continues about the relationship between technology and farm structure. This Subcommittee, along with two other subcommittees of the House Agriculture Committee and four other committees of Congress, requested OTA to conduct an assessment of emerging agricultural technologies and their relationship to public policy and changing farm structure. OTA is now working on this assessment. The purpose of the project is to: 1) determine the most likely picture of U.S. agriculture in the year 2000 with attending impacts, 2) explain how technological advances may influence this picture, and 3) analyze public policies to mitigate possible adverse impacts or to take advantage of potential benefits.

Findings from the assessment that relate directly to the 1985 Farm Bill will be available later this year. Preliminary findings indicate that emerging technologies in biotechnology and communication and information technologies will play a very important role in structural change given present public policies. These technologies will be applicable mostly, for economic and technical efficiency reasons, to large, integrated farming operations.

There are many policy questions to resolve including: 1) Who are the beneficiaries of present farm policies? 2) What are the impacts of less than 10 percent of all farms producing over 90 percent of the food and fiber for domestic and world markets? 3) Are basic changes needed in commodity policies? 4) What is the role of USDA and land-grant universities in assisting 90 percent of the farms that produce only 10 percent of the U.S. food and fiber? 5) In what form should the assistance be?

The OTA assessment will establish the relationships among: emerging technologies, current public policies, and changing farm structure. We hope to be able to indicate the most important relationships so that policymakers will know where the key pressure points are. Our goal is to provide policymakers with a picture of what the agricultural sector will look like as we enter the 21st Century with all the attending impacts that go with it. If policymakers are satisfied with what they see, probably little, if any, changes in public policy will be needed. If, however, they do not like what

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they see, they may draw upon the study's or other policy options to mitigate the negative impacts.

4. Biotechnology Initiatives

Land-grant universities were created by Congress to serve the public. The agricultural component of the land-grant universities has unique responsibilities to conduct and extend results of research for the public benefit. Traditionally, those research results have been readily and freely available to the public -- having no private property or exclusivity rights attached to them. Historically, research, whose results were to be held in confidence or have private property rights attached to them, was frowned upon. Policy changes that have occurred over the past 15 years hold the potential for substantially changing this traditional ready and free access concept of land-grant university research. Some changes have already occurred; others have the potential for occurring very rapidly.

Questions of how land-grant universities might adjust to these developments have been the subject of extensive study. However, the impact on the unique nature or "social contract" of the land-grant system has received little attention.

Policy changes regarding property rights in agricultural research had their origin in the enactment of the Plant Variety Protection Act of 1970. Previously, patent protection in plants was limited to asexually reproduced material -- mainly orchard fruits and ornamental flowers. The Plant Variety Protection Act, amended in 1980, provides that a breeder of a new, stable, and uniform variety of sexually reproduced plants can restrain other seedsmen from reproducing and selling that variety for 17 years.

Of possibly greater significance was the 1980 landmark U.S. Supreme Court decision, Diamond vs. Chakrabarty, which held that the inventor of a new micro-organism, whose invention otherwise met the legal requirements for obtaining a patent, could not be denied a patent solely because it was alive. This decision opened the door for patenting of potentially all new products of the biotechnology era.

Since the passage of the Plant Variety Protection Act and the Chakrabarty decision, private sector interest in agricultural research has mushroomed. OTA found in the study Commercial Biotechnology: An International Analysis that there were 61 companies pursuing applications of biotechnology in animal agriculture and 52 companies applying biotechnology to plants in 1983. The companies involved range from established agricultural chemical suppliers such as Monsanto, DuPont, Dow, Eli Lilly, and American Cyanamid to new biotechnology firms such as Genentech, Biotechnica International, MGI, and Genex.

Most of these firms have developed their own in-house research capability employing molecular biologists, biochemists, geneticists, plant breeders, and veterinarians. While the emphasis in plant and animal science in the past was that of selection and breeding for specific desired traits, now the emphasis has changed to understanding the factors that control the genetic traits and overtly changing them. Progress is already being made with growth hormones, vaccines, and herbicide-resistant varieties. Several genetically engineered products are very close to being marketed commercially.

Relationships are also developing between many of these firms and universities. For example, Monsanto has a 5-year, $23.5 million contract with Washington University under which individual research projects are conducted. At Stanford University, six corporate sponsors (General Foods; Koopers Corporation, Inc.; Bendix Corporation; Mead Corporation; and McLoren Power and Paper Company) contributed $2.5 million to form the fc -profit

Engenics and the not-for-profit Center for Biotechnology Research. Michigan State University created Neogen to seek venture capital for limited partnerships to develop and market innovations arising out of research.

The formation of Neogen points up a significant problem being encountered by the universities in the biotechnology era. Neogen was formed, in part, for the purpose of retaining faculty members who are receiving offers from biotechnology companies. In Neogen, faculty members are allowed to develop their entrepreneurial talent and the associated financial rewards, while remaining at the university.

The formation of Neogen reflects the reality that biotechnology development is resulting in or has the potential to result in a substantial drain on university basic and applied research talent. If leading faculty members are not overtly hired away from universities, they may form their own companies or become consultants. The establishment of biotechnology property rights has substantially heightened scientists' interest in private sector employment opportunities. In the process, questions have arisen over who maintains the property right -- the university, the private firm, or the scientist.

In the Washington University-Monsanto case, the University retains the patent rights while Monsanto has exclusive licensing rights. In Engenics, Stanford likewise gets the patent rights while the Center and the six corporate sponsors receive the royalty-bearing licenses. Neogen will buy patent rights from Michigan State University while the inventor will get a 15 percent royalty or a stock option in Neogen.

Today, such private sector arrangements with land-grant universities integrate business into the university fabric while previously treating government-business ties at arms-length. Questions develop over who controls the university research agenda, the allegiance of scientists to their university employer, the willingness of scientists to discuss research discoveries having a potentially patentable product associated with them, and potential favoritism shown particular companies by the university because of their research ties.

This controversy has caused the land-grant Agricultural Experiment Station Committee on Policy (ESCOP) to express publicly its concerns and develop guidelines to deal with these biotechnology issues.

It should be pointed out that these issues are not new to society. The bio-medical field in particular has been dealing with these issues since the late 1970's. R. C. Herdman, in the article "University-Industrial Relationships" in Cancer Investigation, discusses the controversies surrounding these issues as they relate to nonland-grant or private universities in the bio-medical area. These relationships between the private sector and private universities have been flourishing and as Herdman states, "Universities have concluded today as they have in the past, that the industrial interface is valuable." Indeed Congress, by passing patent law amendments in 1980 to simplify the framework wherein not-for-profit and small businesses may engage in university-industry relationships, has indicated its intent in this area. And President Reagan, to the legally allowable extent, has extended these benefits to large businesses by Executive order.

The public policy question is whether or not land-grant universities chartered by Congress and publicly funded on a continuing basis by appropriations are to be considered unique. If so, these adjustments imply in part that potential basic changes in the relationships between land-grant universities and the public may be forthcoming.

The advent of patent rights, exclusive licensing, and private sector investment via joint ventures and contractual arrangements in public sector research have the potential for changing the distribution of benefits from land-grant research discoveries.* This occurs for at least four reasons:

- By exclusive licensing or transfer of patent rights to private firms, the right to use discoveries is no longer freely available — even if information on the discovery itself is freely available.
- Certain individuals and/or firms are conferred the benefits of specific land-grant research, to a potentially unfair advantage over others. Without such transfer of rights, the benefits are available to anyone who adapts the discovery to commercial use.
- The costs of the resulting discoveries are internalized in the price of the resulting product. The price the public pays for the product also includes profits associated with the conferrence of the rights. Thus it can be argued that society pays for both the cost of the research and for its benefits. Without the conferrence of property rights, profits are minimized by competition.
- Private sector-public sector inequities are virtually assured in any granting of research property rights to any individual firm. This occurs because with a relatively small private sector investment there is access to a much broader range of current and prior research.

The argument does not, however, flow exclusively against the conferrence of private sector property rights by land-grant universities. There are at least three main counterbalancing arguments:

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* Similar implications may also exist for ARS research to the extent that patent rights and exclusive licensing arrangements are created by ARS.

- With the conferrence of private property rights and the associated private sector investment, the quantity of research discoveries may increase. A study by Robert Evenson at Yale, for example, found a sharp acceleration in private plant breeding programs after the 1970 Plant Variety Protection Act was enacted into law. Over 1,088 patent certificates were granted by February 1, 1983.
- Without land-grant university involvement in private sector funded research, it may not be able to retain the top quality scientists needed to conduct cutting-edge agricultural research. In the process, the agricultural research, extension, and teaching programs would all suffer.
- Finally, patent monopoly rights may be necessary to attract the capital investment needed to translate land-grant university scientific advances to commercial reality. Without such proprietary protection, new discoveries may not be able to compete for resources for development to marketable products or technologies and thus public availability.

If policymakers desire that land-grant universities not confer property rights, it will be necessary to provide the level of funding whereby they can compete with nonland-grant or private universities who confer such rights. That is a basic public policy decision -- maybe the most basic decision since the land-grant system was created over a hundred years ago. Surely establishment of proprietary patent rights, exclusive licensing, and private sector investment in land-grant universities needs careful assessment and exploration of the issues by policymakers with the welfare of the universities, the scientific enterprise, and the public in mind.

Thank you for inviting me to testify Mr. Chairman. I would be happy to try to answer any questions.

STATEMENT OF DR. WILLIAM E. MARSHALL
CHAIRMAN, NATIONAL AGRICULTURAL RESEARCH AND EXTENSION USERS ADVISORY BOARD
BEFORE THE U. S. HOUSE OF REPRESENTATIVES COMMITTEE ON AGRICULTURE SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND FOREIGN AGRICULTURE

My name is William Marshall, President of the Microbial Genetics Division, Pioneer Hi-Bred International, Inc., of Johnston, Iowa. I am testifying today as Chairman of the National Agricultural Research and Extension Users Advisory Board. I wish to thank Chairman Brown and the members of the Subcommittee for this opportunity to place before you the opinions of the private sector as expressed through the 25 members of the Users Advisory Board.

As you are aware, the Users Advisory Board was established by the National Agricultural Research and Extension Teaching Policy Act of 1977 to provide information and independent advise to the President and Congress on issues of concern to users of agricultural research and extension services. Copies of the Board's reports for the past year have been distributed to members of this committee. Today, I would like to briefly apprise you of some of our primary concerns. Before I speak to the individual sections requested in your letter of May 8, I would like to put into overview the Board's impressions of agricultural research in America today. The Board is proud of the accomplishments of our agricultural research institutions. Its accomplishments are heralded around the world. There is, however, a concern that the world has changed and that these changes are placing new demands on our agricultural institutions. It is the feeling of the Board that these new demands do not translate directly into new dollars for additional research. It is true that agribusiness has grown and with it agricultural research must also grow. We are more concerned, however, with prioritization, focus and redirection of existing as well as new programs.

Our discussions lead to recommendations in two broad areas. The first challenge is to broaden the disciplinary reach of our Experiment Stations and the Agricultural Research Service. It is the strong feeling of the Board that disciplines, particularly those related to biology, should be brought into the experimental designs and teachings in our Colleges of Agriculture in a more direct and effective way. Secondly, input costs have escalated more rapidly than yields or markets. Economists and more specifically agricultural economists should focus their efforts to understanding the new picture of world farming and work more closely with researchers to insure that our technical programs, if successful, will provide economic benefit to our farmers, agribusinesses, and the Nation.

We agree that biotechnology in agriculture should be given highest priority and focused toward major objectives of large economic benefit to American farming. We feel the area of reducing input costs and preserving our national rsources to be two areas where biotechnology uniquely provides a significant potential benefit.

With that as an overview, I would like to turn to each one of the issues which you requested.

In my opinion, the best way to encourage greater use of economic and critical path analyses for setting priorities is to determine what economic benefits will be derived from successful research. What are the economic assumptions which lead an investigator to pursue a particular research goal? The challenging of economic assumptions is an exercise that often helps the scientist plan his strategy. The Joint Council and the Users Advisory Board may be the Boards most capable of probing areas of economic assumptions - since they represent the producers and users of research. I do not believe that more detailed priorities or explicit rationale is wise. What the UAB often finds is that the research objective, per se, needs more explicit rationale, not the detailed approach. Researchers continue to work in a specific field because it is familiar. We have to develop researchers that are flexible in their disciplines as well as problem solving.

The supply/demand projections should certainly be used in setting priorities. We feel there is a need for the Joint Council to place greater priority on environmentally desirable technologies. Increasing yields does not assure the consumer that the soil, water, and air will not be damaged for future generations. The Users Advisory Board feels that the Joint Council should examine ways to decrease input costs while maintaining yields. Between 1979 and 1982 input costs have risen 30 percent, an average for all commodities. This increase is due largely to the cost of capital as well as increased costs of petroleum. The farmer's margin has been shrinking constantly since energy and capital costs started to rise. There was only a brief period when the developing nations, because of low interest loans, were able to buy sufficient quantities of our exports. Agricultural research can play an important role in identifying the high input costs as well as providing options to reduce these costs through new technologies. Too much of our agricultural research is devoted to increasing yields with the tacit assumption that that will increase the profitability to the farmer. That hypothesis should be challenged. Contributions of agricultural research to a viable U.S. agriculture must be measured by profitability or the margin rather than productivity.

The personal computer may represent the best near-term tool to assisting both limited resource farmers as well as large producers in improving their margins. The technology for analysis and communications exists but we haven't sufficient information on individual farms. We believe that the County Extension Agent and the Extention Specialists are well situated to develop the database which would show limited resource farmers the appropriate management practice for his crops or livestock. Analyses can be performed which would show the optimum size of his farm, needed inputs, hired labor, size of capital and herd.

The potential of agricultural biotechnology holds the greatest long-term potential technology for reducing input costs and protecting our natural resources. It is imperative that our established agricultural research organizations become involved in evaluating this potential. Through this involvement they also establish the appropriate database to assist in developing a regulatory approval process. At present, most of the funding for biotechnology in agriculture comes from federal agencies outside the USDA. In general, fewer than 15 of our State Agricultural Experiment Stations are able to obtain sufficient funds to work in this area. Their ability to attract these funds appears to be related directly to the number of basic scientists working within their basic science departments. Simply stated, many of our experiment stations no longer have the basic science departments that were once within their College of Agriculture. The stability and mix of funding are an important policy issue if economic performance is the principal reason for Congressional interest in research and development.

Since 1979, agencies outside of the USDA have increased their support of the State Agricultural Experiment Stations from $61 million in 1979 to $78 million in 1982, a 28 percent increase. At the same time, the USDA has increased its funding by approximately 38 percent but on a larger higher base. State appropriations have increased about the same, i.e., 28 percent. Clearly these data indicate that Federal policymakers and legislators are supporting agricultural research in a serious way and providing stable support.

We must stimulate technological development in the public and private sectors through providing an appropriate mix of government funds. First-class scientists who can successfully compete for basic research funds appropriated to the Competitive Grants program should be attracted to conduct basic biological research using USDA funds regardless of their institutional affiliations. The USDA Competitive Grants program was established in 1978 to provide support for basic agricultural research of high-quality and significance without regard to the nature of the research institution. The Competitive Grants program provides training opportunities to attract superior young scientists to agricultural problems. Perceptive scientists who focus their energies on developing frontier tools and techniques should continue to be supported by reauthorizing the Competitive Grants program. **We recommend that the Competitive Grants program, (Section 2(b) of the Act of August 4, 1965, P.L. 89-106, as amended by Section 1414 of P.L. 95-13 (7 U.S.C. 450(b)) be restricted to basic research rather than basic and applied research as the law currently reads.**

In addition, we need to refocus and simultaneously fund the Special Grants program. The focus of the Special Grants program should be used to achieve the following objectives:

1. Strengthen the scientific capacity of our state agricultural experiment stations.

2. Support institutional affiliations which stimulate rapid utilization of emerging scientific techniques to reduce agricultural input costs including seed, fertilizer, pesticides and fungicides, labor, fuel, water, farm machinery, and interest.

3. Stimulate increased attention to high priority science for agriculture through competitive funding for major scientific areas.

We must stimulate affiliations of state agricultural experiment station scientists with basic scientists in other land-grant university departments and well-known non-land-grant universities. Colleges such as the University of Illinois, Cornell University, and The Ohio State University, should receive funds which support collaborative biotechnology centers across department and college boundaries. The field plots and barns of schools, such as the University of Connecticut, should be linked through a grant to the gene-splicing laboratories of Harvard University to accelerate areas such as biogenetic product development. Funds should be awarded competitively to SAES which submit proposals for collaborative cross-campus or multi-institutional research.

We recommend that Section 2(c)(1) of the Act of August 4, 1965, PIL. 89-106, as amended by Section 1414 of P.L. 95-13 (7 U.S.C. 450) be revised as follows:

> **The Secretary of Agriculture is authorized to make competitive grants for periods not to exceed five years to State Agricultural Experiment Stations to stimulate increased attention to high priority science for agriculture that (A) strengthen the scientific capacity of our state agricultural experiment stations and promote research partnerships between state agricultural experiment stations, basic science departments in: (1) nonagricultural departments of land-grant universities, (2) all other**

colleges and universities, (3) other research institutions and organizations, and (4) corporations and high venture capital firms having a demonstrable capacity in food and agricultural science.

It is important to focus the attention of our State Experiment Stations on reducing input costs. The private sector laboratories do not have the same objectives as the public sector units do. What the private sector does is promise to return the greatest return to its shareholders. Solutions to reducing chemical use, seed costs and machinery are not in the best interest of corporations. The Nation looks to our agricultural colleges and universities to solve those problems.

The Users Advisory Board in its recommendation in July of 1983 indicated that there was considerable benefit in transferring agricultural economists into ARS. We believe that the Economic Research Service needs to expand its responsibilities to include economic policy analysis of changes in agricultural research. These, however, should not be theoretical treatises, but rather they should lend the assistance of working agricultural economists to assist individual researchers in developing the research thinking and design of experimentation. We are not recommending that the economists play a role in directing research but rather assist the researcher in the researcher's thinking regarding the economic benefit if the research is successful.

The State Extension Service is a powerful network of off-campus educators who act as a conduit both from the university to the citizen and back from the citizen to the educator. We believe that this statewide service is of considerable value to our Nation. In these days of change on our rural lands, extension plays an important role and needs to play an even more valuable role. One of the ways it can increase its value is by developing teaching skills in the area of the use of the personal computer. The private sector is not depending on the extension service for prototype software. The skills to develop software and skills to develop the computers themselves lie principally in the private sector. The skill that is absent in the private sector is the skill of on-farm teaching. The County Agents and Extension Specialists can provide this necessary skill.

Lastly, the Users Advisory Board is deeply concerned about the quality of our agricultural schools and the quality of our agricultural students. This is not to be interpreted as a criticism but rather as an expression of the private sector's willingness and desire to help Colleges of Agriculture provide the private sector with the best students in the world. The most often heard areas for improvement are better skills in problem solving, more fundamental knowledge in appropriate basic sciences, and the ability to communicate. Some of these skills are not traditionally taught in a classroom and may require a cooperative arrangement between private sector in the locals of our Colleges of Agriculture. The industries represented by the Users Advisory Board have expressed a willingness to work with individual faculty members toward improving these skills on campus either through seminars or through exchange programs.

Thank you for the opportunity of personally expressing the views of the Users Advisory Board. Our members put in about 250 days last year on these important subjects and it has been our privilege to see so much dedication and enthusiam put against assuring that American technology is best seen in agriculture. It is important that we maintain this focus.

Testimony of Dr. John T. Marvel
General Manager, Research Division
Monsanto Agricultural Products Company

Before the Subcommittee on
Department Operations, Research, and Foreign Agriculture
Of the House Agricultural Committee

U.S. House of Representatives
Washington, D.C.

June 7, 1984

Mr. Chairman and distinguished members of the Subcommittee, I am Dr. John T. Marvel, the General Manager of Monsanto Agricultural Products Company's Research Division. Monsanto Agricultural Products Company is an operating unit of Monsanto Company with over one billion dollars in agricultural product sales in 1983. I am also a member of the National Agricultural Research and Extension Users Advisory Board, Chairman of the Industrial Research Institute's Federal Science and Technology Committee's Subcommittee on Agriculture, member of the House Office of Technology Assessment Advisory Panel for Agriculture, and a participant on various other agriculture related committees. In addition, I am an active manager of a family farm in central Illinois.

We appreciate this opportunity to state our views on biotechnology and biotechnology regulation from an industry perspective. I will lay the foundation for the importance of biotechnology to the future of agriculture and the world food supply. Integral in this future are basic research, regulation of the products of that research, and intellectual property rights.

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Dr. Will Carpenter, the General Manager of Monsanto Agricultural Products Company's Technology Division, will give our perspective on Federal biotechnology regulation and the protection of intellectual property rights in greater depth.

Agriculture is the largest of the world's industries. The importance of agriculture in America relative to employment, gross national product and the balance of trade has been well documented. The world population is currently estimated to be over 4.7 billion people with an annual growth rate of approximately 1.8% per year. This rate of growth will necessitate a doubling of food production within 40 years to keep pace with population growth, most of which will occur in Third World countries.

Modern agriculture can be characterized by advances in plant breeding and the development of improved farm implements, fertilizers, and pesticides. Genetically superior plants, derived from current crop improvement programs, require a high level of crop management. This crop management consists, in part, of an increasing need for large amounts of nitrogen fertilizers, herbicides and other pesticides, all of which have various disadvantages. For example, intensive inbreeding and narrowing of the genetic pool of widely cultivated crops, such as corn, are causing increased concern about susceptibility of these major crops to catastrophic disease and pest outbreaks.

Biotechnology is a tool that can be used by scientists to insure that man's food supplies are met. Biotechnology, in a general sense, is the use of living organisms or their components in agricultural, pharmaceutical, food, chemical and other industrial processes for the development of a product. Biotechnology is a process, not a product. The critical importance of this maturing technology cannot be over-emphasized.

Advances in biotechnology which will improve crop productivity fall into two areas: genetically engineered plants and genetically engineered microbial pesticides. While genetic engineering will ultimately result in plants with enhanced fertilizer use efficiency, enhanced protein and seed oil production, and improved bread-making qualities, much of the earlier progress will come from the transfer of simpler, single gene traits, such as disease, insect and herbicide resistance, since such transfers are now technically feasible.

Significant effort is being devoted to the identification and isolation of herbicide resistant genes which can be inserted into plants to make them less sensitive to non-selective herbicides. There are three different routes by which a plant can defend itself against the action of a herbicide: preventing uptake of the toxin, detoxifying the herbicide by degrading it, and modifying the target site of the herbicide.

Efforts are also being devoted to identify and transfer microbial genes coding for antibiotic production to plants so that plants can produce their own fungicides and insecticides. Such developments could dramatically impact the environment by elimination of many current control measures.

However, the major impediment to the advancement of biotechnology in agriculture and food production is the lack of knowledge about gene organization and regulation in higher organisms such as plants. There is a large gap in the understanding of the basic plant biochemical mechanisms which regulate growth, development and reproduction. Identification and isolation of agriculturally important genes for transfer into crop species are of paramount interest and importance. Once the genes necessary for valuable plant traits have been identified, practical applications will follow rapidly.

The necessary basic knowledge in biotechnology will come only by an adequately funded, long range and directed commitment by the Federal government in basic agricultural research.

The pharmaceutical industry is an example of what can be accomplished with biotechnology in a relatively short time when there is an adequate base of fundamental knowledge. A partial list of products produced by biotechnology which are under clinical or animal test include: twelve plus subtypes of interferon, human growth hormone, human calcitonin, human serum albumin, monoclonal antibodies, porcine growth hormone, bovine growth hormone, foot and mouth disease vaccine, and bovine leukocyte interferon. Human insulin produced by biotechnology has already been cleared by the Food and Drug Administration for use. These examples clearly show what can be accomplished when an adequate base of knowledge exists.

In parallel with efforts directed towards the genetic engineering of plants, are efforts to genetically engineer microorganisms that live in close association with crop plants. Genetic engineering of these associative microbes may lead to more effective and more environmentally desirable pesticides to protect the large percentage of the world's food supply that is lost each year to insects and disease.

Another important area of biotechnology application which I will address is animal production. Animals are a source of protein and other products useful to mankind. Several different approaches to increasing this source of protein are being explored using biotechnology. The production of porcine and bovine growth hormones using genetically engineered microbes is one area under development.

Another area under investigation is amino acid production since higher animals cannot produce all the amino acids they need for protein synthesis. If one of the essential amino acids is missing, protein synthesis will stop, and the other amino acids will not be utilized. The limiting amino acid in a particular case is a function of the animal and its feed. Various deficiencies of seeds in certain amino acids do not allow either cereal grains or legumes to provide a balanced diet. Supplementation of the limiting amino acids from other sources is necessary. The major source of animal feed in the U.S. is soybean meal. The limiting amino acid in this feed is lysine for swine and methionine for poultry. Other limiting amino acids include tryptophan and threonine. One probable use of recombinant DNA techniques will be to increase the yields and lower the cost of production of these limiting building blocks.

Modern animal husbandry practice utilizes intensive management techniques. Close confinement of animals brought about by these practices aggravates management-induced disease in animals. Frequently the disease spreads so quickly that antibiotics cannot be administered. For this reason, genetically engineered vaccines are being developed to prevent management-induced diseases, such as neonatal scours in pigs and calves. Other animal viral vaccines which are in testing include avian leukemia virus, foot and mouth disease, virus avial myeloblastosis virus, and Rous sarcome virus.

Mr. Chairman, I have covered many exciting areas of agricultural potential in biotechnology which will make a strong and positive influence on all mankind. The pharmaceutical industry already has products that are in the marketplace, clinical trials or in animal testing. The outlook for agricultural biotechnology applications is even more exciting. The potential of increasing the world food supply while decreasing inputs and environmental losses will be a boon for this country's agriculture and for the world.

However, many obstacles must be overcome before the full potential of biotechnology can be realized. The lack of fundamental knowledge of genetics, biochemistry, and physiology in plants and higher organisms must be remedied before rapid progress can be made.

The current unstable regulatory climate is impeding progress and must be stabilized.

Finally, the development of biotechnology applications requires an enormous input of financial and human resources. This investment must be protected with stronger and uniform intellectual property rights. Without this protection the willingness for industry to invest in biotechnology development will be hampered.

Thank you.

STATEMENT OF
DR. LAWRENCE BUSCH
CO-CHAIR OF
COMMITTEE FOR AGRICULTURAL RESEARCH POLICY
UNIVERSITY OF KENTUCKY
BEFORE THE
SUBCOMMITTEE ON DEPARTMENT OPERATIONS,
RESEARCH, AND FOREIGN AGRICULTURE
OF THE
COMMITTEE ON AGRICULTURE
U.S. HOUSE OF REPRESENTATIVES
JUNE 7, 1984

Mr. Chairman, members of the Committee, my name is Lawrence Busch. I am professor of sociology, co-chair of the Committee for Agricultural Research Policy at the University of Kentucky, and co-author and editor of three books and numberous scientific articles on agricultural research. I appreciate the opportunity to present my view on planning and policy issues facing U.S. public sector agricultural research. I am pleased that your committee has been engaged in an in-depth analysis of agricultural research. I welcome the opportunity to assist you in your work.

You have already had the benefit of the testimony of many leading authorities and research administrators in agricultural research. Although my work bears on the broad range of issue addressed previously, I will focus only upon the issues of (1) agricultural research and development and farm size, (2) the socioeconomic impact of the new plant biotechnologies which are being examined today in your committee.

Research and Development and Farm Concentration

The basis of this part of my statement derives primarily from a National Science Foundation (Program on Science Resource Studies) grant to examine statistically the effect of public agricultural research on the concentration of farm production from 1915-1973. It is generally recognized that the financial and human resources devoted to public sector agricultural research have increased substantially throughout this century. Furthermore, general trends in the concentration of farm production can be easily identified. The objective of our research was to assess the independent and direct role which research has played in producing these changes in the farm sector.

Theoretical Framework and Analysis

Research and Development (R & D) as organized activities date from the seventeenth century when capitalism as an economic system came into being. The competition of the marketplace, so well described by Adam Smith, created a powerful demand for new technologies. Simply put, in a competitive market, profits tend to decline toward zero. Therefore, the farmer who wishes to increase his profit is compelled to reduce costs. Cost reduction may be accomplished through either improved management of resources and labor, or technical innovation. This creates an enormous demand for new technology.

However, as Ruttan explains:

> Under competitive market conditions the early adopters of the new technology...tend to gain while the late adopters are forced by the product market "treadmill" to adopt the new technology in order to avoid even greater losses than if they retained the old technology (1980:540).

In short, the completion of the innovation process does not eliminate the demand for further innovation. Instead, it starts the entire process all over again. Thus, in competitive markets, there is constant, high demand for technical change.

Over time, the continuous infusion of new technology into a competitive market is likely to have a number of effects on that market. First, it is likely that early adopters of new technology will be able to significantly increase their market share. Conversely, late adopters are likely to be driven out of the market by their failure to realize a satisfactory rate of return on investment.

A second consequence of the treadmill is a vast increase in productivity. In general, lower production costs lead to decreased prices which in turn increase the size of the market, and "free" labor and capital for use in other production processes. One needs only to look at the vast increase in material welfare of the Western world over the last three centuries for evidence of this.

When applied to the farm sector, this general theoretical perspective must be modified to some degree. Farming forms a special case in that: 1) With few exceptions farming is a land-extensive operation. This puts real upper size limits on farm operations as a result of difficulties of labor control. That is to say, it is impossible to oversee the activities of someone located perhaps miles away. Some efforts have been made to overcome this problem by designing machinery that moves workers through the fields. However, for most types of farms, this is unworkable. Therefore, while farming has become more concentrated over the last century, concentration in farming has not approached that in manufacturing. 2) Farming is linked to certain basic biological processes (e.g., seasons, photoperiod, temperature, etc.) that limit the speed of production, make for peak periods of labor demand, and restrict the return on investment. In contrast, manufacturing can relatively easily overcome many of these obstacles through improved machinery which speeds the flow of production. In agriculture, in only a few cases, has it been possible to partially overcome these obstacles (e.g., industrialized poultry production). Instead, the tendency has been for the percent of value added on the farm to decrease while that added off the farm increases. 3) As the products of most farming are edible, it is possible to remain a (part-time) farmer while producing very little. This means that relatively large numbers of small producers can remain in farming even though their operations are, in a strict sense, unprofitable.

Generally speaking, results indicate that, independent of other factors likely to increase farm size, publicly financed R & D has tended to increase average farm size, the number of large (1000+ acre) farms, and large farms as a percentage of the total.

Also worthy of note is the relative impact of each of the measures of R & D. USDA expenditures appear only weakly related to farm concentration measures, at best. This may be due to the basic research orientation of that agency, though a recent study suggests that there is no difference between USDA and the experiment stations in their basic research orientation (Busch and Lacy, 1983). More likely is that the regional and national mandate of USDA is reflected in research results. Specifically, the linkage to the farm sector and the responsiveness to farmers' demands is certainly weaker for USDA.

Policy Implications

Our data clearly suggest that public sector agricultural R & D has had the effect of increasing concentration in the farm sector. That concentration in turn has been followed by increased commercialization and decreased labor needs. We shall assume that further economic concentration in agriculture is not desirable. Such concentration is likely to drive prices up in the long run, permit certain large farms to unduly control local or regional markets, and undermine domestic food security (Busch and Lacy, 1984). What, then, are the policy options that might be pursued? Two broad options appear open:

1. Redirect agricultural research. While our study indicates that agricultural R & D encourages concentration in farming, it should be remembered that this relationship is not a physical but a social one. In other words, there is nothing inherent in agricultural research that requires that this relationship be present. Therefore, redirection of research might yield different results.

Several years ago, a study sponsored by ESCOP (1981) revealed that only about 10% of all research was clearly directed to larger farms. This figure does not appear unreasonable. What is more likely to be the case is that the interaction between research and the larger social milieu encourages larger scale units. Consider some of the problems:

a. Specialized research tends to be applicable only on specialized farms. Thus, successful farmers have tended to specialize in the production of one or a few commodities. This, in turn, demands the necessary capital to take the risk of literally putting all one's eggs in one basket. More interdisciplinary research that looks at farms as socioeconomic and ecological systems might well reduce the bias toward highly capitalized enterprises. There is some evidence that this problem has now been recognized and is beginning to be addressed (e.g., Russell, 1982).

b. Research goals may reflect hidden biases against smaller operators. For example, when the tomato harvester and associated tomato varieties were developed in California, the machine was only profitable on farms much above the average size (Friedland and Barton, 1975). Procedures for monitoring and forecasting the effects of research on farm concentration, perhaps along the lines developed by Friedland and Kappel (1979), might be developed.

c. To date larger, better capitalized farms have tended to have better access to research agenda setting than smaller farms. Advisory groups to public research organizations tend to represent larger farms. Thus, research agendas tend to favor the needs of larger producers. Reorganization of advisory groups to serve a cross section of farmers (as well as other interested groups) might also tend to reduce large producer bias.

d. The recent shift away from formula (Hatch) funds and towards larger corporate grants and contracts from input suppliers and output processors, may serve to exacerbate some of the problems noted above. In addition to potential conflicts of interest (NASULGC, 1983), such grants may further bias research towards large producers. In particular, it should be remembered that the scale of operations that will maximize corporate profits may not be the scale that maximizes farmers' profits. Increased Hatch funds and careful attention to the scale implications of both Hatch and corporate grants could serve to mitigate these problems.

In short, redirection of research appears a viable policy option. Nevertheless, by itself it is inadequate. It must be accompanied by a change in the larger social environment.

2. Modify the environment in which research takes place. Farming has always been a risky business. At any time, weather changes can and do

reduce yields. In addition, the socioeconomic environment of farming in the United States has been far from stable. Business cycles, wars, and changing agricultural policies add to the risks involved.

In such an environment, only those who can afford to take risks remain in the business of farming. Those who cannot, sell their farms or make farming a secondary occupation. The risk takers, of course, are those who have the necessary capital.

This suggests another way in which concentration in the farm sector might be abated: by programs specifically designed to equalize the availability of credit, costs of inputs, access to markets, etc. Such programs would compensate for farm size differentials and capital endowments.

Socioeconomic Impacts of the New Plant Biotechnologies

The basis of this part of my statement derives from a National Science Foundation (Program on Ethics and Values in Science and Technology) grant to examine the impacts of the new plant biotechnologies on plant breeding. Methods employed in this study have included a review of the relevant technical literature and interviews (to date) with about 50 scientists and administrators in both the public and private sectors.

Issues Raised

What, then, are likely to be the effects of the new plant biotechnologies on agricultural research and agriculture?

1. The range of disciplines found within the state agricultural experiment stations will change dramatically. Traditionally agricultural experiment stations have house large numbers of plant breeders. These breeders have been seen as the central figures in public sector plant improvement. Microbiologists and molecular geneticists, on the other hand,

have been located in basic science departments often located in colleges of arts and sciences or medicine. In recent years, however, this relationship has begun to change. As plant breeders have retired, it appears that many have been replaced by microbiologists and molecular geneticists.

A report by the National Association of State Universities and Land-Grant Colleges (1983) asserts that 108 additional full-time equivalent scientists (FTE) will be added in the biotechnology disciplines in the next two years.* Interviews of experiment station directors by the authors make clear that many of these positions will be obtained by reducing the scope of conventional breeding programs. A similar process appears to be occurring within the Agricultural Research Service. This shift in disciplinary mix has been accompanied by a change in the types of products released by the experiment station.

The substitution of molecular biologists for plant breeders also reduces the capacity of the stations to produce finished material.

2. Another consequence of the new biotechnologies is a clash among scientific disciplines. The new biotechnologies were developed in microbiology and biochemistry. Conventional plant breeding, on the other hand, has traditionally dealt with whole plants rather than cellular or subcellular material. Members of each of these disciplines tend to approach those in the other disciplines somewhat hesitantly. Breeders find microbiologists naive in their understanding of the complexities of higher plants. On the other hand, microbiologists find plant breeders naive in their lack of understanding of genetic pathways at the molecular level. In addition to

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*This includes both plant and animal sciences as well as food science.

subject matter differences, biotechnologists and breeders differ with respect to background, work environment, and location within the scientific community. Ultimately, however, these barriers are likely to break down, if for no other reason than the enormous pressure being put upon scientists to cooperate. It is likely that those few scientists trained in both biotechnology and conventional breeding will play a pivotal role in the transition to a new form of scientific organization. Particularly in the private sector, endeavors will be interdisciplinary in nature. On the other hand, many, if not most, of these new scientists will have virtually no connection to farm life.

3. There is likely to be a significant increase in the concentration of scientific talent at a small number of public and private institutions. Every state could afford, and has had, a conventional plant breeding program. Every state cannot afford and will not be able to have a comprehensive plant biotechnology program. In fact, it is highly unlikely that all the biotechnology institutions now in existence will still be in existence 10 years from now. In particular, the relative scarcity of scientists trained in the new biotechnology and the strong demand for such scientists by the industrial sector have made it necessary for experiment stations to offer salaries considerably higher than those offered to plant breeders. In addition, the instrumentation currently used for biotechnological research is particularly expensive. In short, there are real barriers to the mounting of a full-fledged biotechnology program in each state. The short-run effect is likely to be one of the concentration of scientific talent in a few states. In the long run, however, the situation should change considerably. First, the demand for new biotechnologists will decline somewhat as some venture capital firms go backrupt. Second, the supply will begin to increase as some universities are able to mount needed training programs. Third, as there are

no restrictions on entry into biotechnology, as there are on physicians and plumbers, in the long run, new entrants' salaries will decline. However, it is likely that instrumentation costs will decline faster than scientists' salaries, allowing replacement of some scientists with lower paid technicians.

4. A significant constraint is likely to develop in educating new scientists. In addition to the fact that few scientists are qualified to offer graduate education in the new biotechnologies, many of those who are qualified are working in industrial settings or in biotechnology units in which little teaching is conducted. As a result, the flow of new scientists into these fields is likely to be relatively small for the near future. In the long run, however, the decline of conventional breeding in the public sector poses the more serious constraint. If the public sector ceases the production of finished varieties, then who will train plant breeders to produce such varieties for the private sector? The changed division of labor between the public and private sectors raises serious questions about the ability of the public sector to continue to fulfill its educational function.

5. The amount of effort devoted to research on minor crops may decline. Instead of using the new biotechnologies to increase the number of food crops available to the human population, or to increase the role of crops of currently minor significance, most of the financial support for the new biotechnologies is being used to increase productivity of major food crops. This is in part a function of market size. Clearly, the existing markets for major crops are larger, and hence of greater interest to the private sector. As a result, the private sector not only is investing most heavily in major crops; it is pressuring the public sector to focus on these crops as well. The public sector is also focusing on major crops as a result of state and national funding practices. Not surprisingly, the commodity groups that are most powerful tend to represent the major crops. With public funds available

for biotechnology programs on only a few crops, research is likely to follow the interests of the most powerful commodity associations. Even in the case of adjoining states with similar crop mixes, competition rather than division of labor appears likely. In short, the high cost of mounting a given biotechnology program, and the decentralized nature of the public research system, are likely to encourage states in the same region to compete rather than cooperate in efforts to broaden the research agenda.

6. A major increase in the size and scope of the commercial seed industry is beginning to take place. More and more, the small seed companies are being relegated to servicing specialized local markets, while the large seed companies capture most of the market for major crops. At the same time, the large seed companies can afford to engage in significant R & D expenditures. The highly competitive market in which the family-owned, local companies are continuing to operate, precludes such R & D investments. Large seed companies have also begun to apply pressure to experiment stations to cease producing finished varieties. Instead, from the point of view of these large seed companies, experiment stations are urged to produce promising materials that will be developed into new varieties by the seed companies. In addition, this shift from the public to the private sector in the development of finished varieties has changed the type of varieties being produced. In particular, researchers in private firms tend to emphasize hybrids over varieties as hybrids must be purchased by farmers year after year and usually have a much higher profit margin. In addition, the new biotechnologies tend to be utilized by private companies in ways quite different from the ways they might be utilized in the public sector. For example, at least one firm is utilizing tissue culture techniques as a way of identifying corn varieties that are resistant to herbicides produced by that company. Eventually, such

herbicides would be sold with seeds as a package to farmers. In short, instead of developing pest-resistant varieties, at least some private companies are developing pesticide-resistant varieties.

7. The new biotechnologies are also likely to have rather dramatic effects on farmers. For example, as the production of finished seed is moved more and more from the experiment stations to the private seed industry, product differentiation of the type found with consumer goods, is likely to invade the farm sector. Thus, farmers are likely to be faced with a bewildering array of seed varieties. Farmers are also likely to be gradually eased out of their traditional roles as the primary clients for plant breeding research. They will be and already are being replaced by seed companies and the chemical companies that run them. Neither scientists nor administrators appear aware of the potential for conflict between the interests of farmers and those of agribusiness. In a very real sense, the new biotechnologies will make farmers dependent on industry in a way that they have never been before. In short, the new biotechnologies may well make possible substantial increases in the production of even heavily researched crops. However, these impacts will only be realized as a result of concommitant changes in the organization of public agricultural research. Linkages between government, university, and industrial research are being rapidly reformulated. Disciplinary relationships are also being rethought. These changes will be fraught with conflict. Some organizations may not survive the transition.

Policy Implications

Perhaps the major policy implication of this study is that certain aspects of the new biotechnologies are unlikely to be developed unless federal money is available for research and education. While state and private funds are already addressing some issues effectively, much of the potential for the new plant biotechnologies will only be realized if federal monies are made available in a relatively unfettered manner.

In addition, given their potential long-term significance for altering American agriculture and agricultural research, Congress should give serious consideration to monitoring continuously progress in this area. While the methods for assessing the impacts of scientific and technical innovations are still in their infancy, they do offer substantial promise for insuring that the public interest is served.

This concludes my testimony, Mr. Chairman. I will be pleased to respond to any questions you or other members of the Committee may wish to ask.

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STATEMENT OF
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COMMITTEE FOR AGRICULTURAL RESEARCH POLICY
UNIVERSITY OF KENTUCKY
BEFORE THE
SUBCOMMITTEE ON DEPARTMENT OPERATIONS,
RESEARCH, AND FOREIGN AGRICULTURE
OF THE
COMMITTEE ON AGRICULTURE
U.S. HOUSE OF REPRESENTATIVES
JUNE 7, 1984

Mr. Chairman, members of the Committee. My name is William Lacy. I am associate professor of sociology, co-chair of the Committee for Agricultural Research Policy at the University of Kentucky and co-author and co-editor of two recent books on U.S. public sector agricultural research. I appreciate your invitation to comment on agricultural policy issues facing our research system. On behalf of our committee and myself let me congratulate you on your efforts to examine and strengthen the scientific research effort which has been a fundamental component of the United States food system and will be a key force in shaping its future.

You have already heard from many research administrators and members of the research community regarding a broad range of issues in agricultural research. Today I would like to share some observations on an issue which is being examined in detail by your Committee: The research policy and the priority setting process and its impact on the research system itself.

Agricultural research and the new technology it helped to generate have been major factors in the transformation of U.S. agriculture to a high technology, mechanized, science-based industry which is the most productive in the world. However, members of the agricultural research community as well as numerous critics have observed that U.S. agriculture is in a critical period of transition. Many people regard this era as one of limits and important choices requiring significant adjustments in the use of resources to ensure long-term sustainability of our food and fiber system. A recent workshop of agricultural research leaders concluded "The critical importance of agriculture to the vitality and strength of this country and the increasing diversity, complexity and intractability of problems facing American agriculture make it imperative that the agricultural research system be able to sustain its level of past performance" (Rockefeller Foundation, 1982). This all suggests the importance of continuing to develop a national agricultural research policy and of integrating it into a coherent national agricultural policy and science policy.

The process of developing effective national agricultural research policy was stimulated by Title XIV of the Food and Agricultural Act of 1977. As you know, three new coordinating bodies were established to improve the planning, coordination and management of agricultural research within and between the various USDA, Federal, and State agencies: The Joint Council on Food and Agricultural Science; the Subcommittee on Food and Renewable Resources of the Federal Coordinating Council on Science, Engineering and Technology; and the National Agricultural Research and Extension Users Advisory Board. Initially, there was skepticism and confusion about their role and utility. One experiment station director commented that the Joint Council and the Users Committee kept the participants occupied rather than really influencing policy. Additionally, the processes used to set research priorities largely served to aggregate what researchers were already doing. In recent years, however, this has begun to change with the institution of some significant internal evaluations and the setting of annual priorities. In addition, there are increasing efforts to conduct long term needs assessment of food, fiber and forest products, and to build the research capacity required to address these needs. The Needs Assessment for Food and Agricultural Sciences is a significant document for improving the priority setting process.

With the progress of priority setting and needs assessment have emerged a number of related questions. To what extent will this process influence and affect the way in which science is conducted in the laboratory, greenhouse, field and office? From work my colleague Dr. Busch and I have conducted, the initial conclusion is that the impact will be negligible. In a survey of over 1400 principal investigators engaged in agricultural research at institutions that receive federal agricultural funds, disciplinary criteria and personal enjoyment were identified as the main reasons for doing research. Scientific curiosity and publication probability in professional journals ranked high as reasons for choosing a particular problem, while priorities of the research organization ranked 11th out of 21 criteria and the idea that the topic was currently a high priority or "hot" topic ranked 15th (Busch and Lacy, 1983).

It shouldn't surprise us, however, that disciplinary criteria dominate the decision making process for a scientist's research agenda. Our survey also revealed that scientists in many agricultural disciplines have little exposure to other disciplines in terms of formal education or formal and informal communication. The modal or most common career path in eight out of sixteen disciplines is to complete all three degrees in the same field with little exposure to fields not closely allied. In addition, U.S. agricultural scientists view disciplinary journals as their major resource of research information, the most important outlet for their findings and the single most important criterion for institutional rewards and promotion. Moreover, scientists overwhelmingly emphasized the creation of disciplinary knowledge and the increase of agricultural productivity as the most important goals for agricultural research. Many other goals, such as improving human health and nutrition, and improving communities, tended to be relegated to one or two disciplines. Moreover, these disciplines tended to have fewer scientists and a more marginal role in the agricultural science system. In addition, there is a strong relationship between those goals to which scientists see their research as contributing and those goals perceived as intrinsically important. In general, scientists tended to undervalue or be relatively unaware of the value of the research of other agricultural disciplines. Such findings highlight the need for a more informed agricultural research policy. They also suggest that the impact of the nationally established priorities may be minimized by the disciplinary structure of agricultural science. Ruttan (1982) noted that by the 1960s "most agricultural experiment station directors had given up any pretension about exercising significant intellectual leadership over the research activities that were funded by the stations..,.. These functions were left to the heads or chairpersons of the disciplinary departments." Many of the emerging nation research priorities, however, are disciplinarily oriented. Furthermore, scientists identified as important criteria for their research choice the availability of research facilities and funding. Consequently, if the priority setting process can be more effectively linked to the provision of funds and facilities, it is likely to have a greater impact on bench scientists. However, as a soil chemist noted in criticizing the fickle nature of research funding:

> The hop on and off band wagon approach taken by the Congress and administration dissipates energy and funds so that basic understanding is bypassed for collection of data that will be meaningless in five years (Busch and Lacy, 1983:225).

Congress and the agricultural research community need to combine effective priority setting with sufficient resources for sustained efforts to meet long-term needs, while retaining the flexibility to respond to urgent short term problems and coordinating the overall effort.

Perhaps the greatest impact of the priorities may be through their influence on the hiring policies and practices of departments and institutions. Substantial recruitment of new scientists will be important in the coming decades if the agricultural sciences are to retain their vitality and address the new research frontiers, particularly in the basic sciences. Research positions generated through increased funding or retirement of older scientists, could be filled in accordance with carefully developed long-term national research priorites. However, this should not be done at the expense of the existing programs which, according to most observers, are already underfunded.

A number of the important emerging priority areas, as well as those that are likely to emerge in the future, will require interdisciplinary skills and training. Increasing the capacity of the current system to engage in interdisciplinary research may require not only changes in the training of scientists, but modifications of (1) research strategies and methodologies as well as (2) organizational structures. Some suggestions for accomplishing this are as follows:

a. Graduate students could be provided fellowships or assistantships to pursue minors outside of their disciplines. For example, some agronomists might be encouraged to minor in animal nutrition.

b. Faculty could be funded to take sabbatical and postdoctoral leaves at non-land-grant institutions and in disciplines other than their own.

c. Agricultural disciplinary societies could establish annual awards for the best interdisciplinary research.

d. More joint appointments across departmental lines (in both government and the universities) could be developed.

e. In hiring decisions, scientists and research administrators should take into account an applicant's breadth of knowledge and experience as well as his or her understanding of a particular special area. In addition, administrators need actively to seek qualified women and minority members for research positions. By encouraging greater breadth and diversity among agricultural scientists we may achieve the goals of greater flexibility in meeting changing needs, increased interdisciplinary interaction, and, perhaps, greater creativity.

f. The current reward system in agricultural research institutions also needs to be reorganized so as to encourage scientists to pursue more high risk, interdisciplinary and long-term research. University administrators often seek standardized measures for evaluating the performance of all faculty and ignore the special roles of agricultural research. Better systems for promoting and rewarding high quality research that addresses national priorites need to be developed.

g. Finally, administrators should consider the establishment of several multidisciplinary, multicommodity research projects and programs. Some creative efforts in this area are just beginning to develop. For example, Integrated Pest Management (IPM) is an innovative multidisciplinary research strategy which promotes the development of pest control methods employing a combination of biological, mechanical and chemical means. Farming systems is a second multidisicplinary, multicommodity research strategy which has developed over the last decade largely out of the experiences of the International Agricultural Research Centers. While far from a reality even in these centers, it provides a model that could refocus the emphasis in agricultural research away from disciplinary and commodity concerns toward complex interactions among and between people, crops, soil, and livestock. Other new interdisciplinary structures which are emerging are: (1) Solutions to Environmental and Economic Problems, a federal and state funded, multidisciplinary research effort to develop new techniques and strategies to control soil erosion in the croplands of Washington, Oregon and Idaho, and (2) the Collaborative Research Support Programs, USAID and agricultural college funded, multidisciplinary inter-university programs which involve U.S. social and natural scientists collaborating on both basic and applied research with similar groups from developing countries. Many of these institutional arrangements require new and creative funding, since neither the existing competitive grant nor the existing formula funding model are effective in stimulating multidisciplinary research across state boundaries with the aim of addressing regional or national agricultural priorities.

In addition to a more effective linkage between the priority setting process and the world of the scientist, there is a continuing need to analyze and review the policy process itself. The efforts to date are to be commended. They could be improved further by the following actions: (1) Given the importance of agricultural research priorities, consideration should also be given to including the full range of constituents for agricultural research in the process of developing priorities. (2) In addition, the process could be improved by the establishment of several multidisciplinary units in which policy research could be conducted. Some of the larger land grant universities appear to have the resources, as well as the academic freedom necessary to carry out this task.

Finally, the development of policy requires the ability to make judgments about the value of alternative research priorities, the ability to assess the results of policies once they are implemeted, and eventually the ability to develop forecasting techniques. A number of increasingly powerful methodologies are being developed for interpreting scientific, technical and economic information in order to increase the effectiveness of research efforts (See Ruttan, 1982). In addition, methodologies are beginning to emerge which attempt to assess the results of policies, forecast the consequences, and integrate technical, economic, social, aesthetic and moral considerations. Although formal social impact assessment of changing technologies in U.S. agriculture is still in its infancy, researchers utilizing this approach have provided insights on such topics as the socioeconomic consequences of automated vegetable harvesting (Friedland and Barton, 1975; Friedland, et al., 1981), tobacco harvesting, center pivot irrigation, and organic and no-till cultivation (Berardi and Geisler, 1984).

Resources should be devoted to these new methodlogies if they are to move beyond their infancy and contribute to effective research resource allocation and priority planning. Furthermore, efforts should be devoted to preparing scientists to utilize these methodologies and assessment strategies for agricultural research. Moreover, research planning will require closer collaboration among natural and social scientists as planners address not only the possibilities of advancing knowledge or technology, if particular resource appropriations are made, but also consider the value to society of the new knowledge or technology. Finally, to meet the diverse and complex research agenda for a long-term, sustainable, nutritious and equitable food system in the U.S. will entail levels of public funding of agricultural research more commensurate with its value to society and with its research needs.

This concludes my testimony Mr. Chairman. I will be pleased to respond to any questions you or other members of the Committee may wish to ask. Again, I thank you for providing this opportunity to discuss these issues with you.

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TESTIMONY TO
U. S. HOUSE OF REPRESENTATIVES
COMMITTEE ON AGRICULTURE
SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND FOREIGN AGRICULTURE

by

Perry L. Adkisson
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The Texas A&M University System
College Station, TX 77843
June 7, 1984

Mr. Chairman, Distinguished Members of the Committee, I am Perry Adkisson, Professor of Entomology and Deputy Chancellor of the Texas A&M University System, where I have administrative responsibilities for our state agricultural experiment station and extension service. In addition, I am Executive Director of the Consortium for Integrated Pest Management (CIPM), an organization of 16 major land grant universities that are conducting research to develop improved integrated pest management systems for all the pests, insects, diseases, weeds, and nematodes of several major crops. It is a privilege for me to appear before you today and I appreciate your inviting me to testify on the current status of integrated pest management (IPM) and prospects and needs for the future.

Integrated pest management is a system of pest control which combines the use of all available tactics (cultural, chemical, and biological) to suppress pests below crop damaging levels. It is a common sense approach to crop protection which works in harmony with nature, not against it. Integrated control uses cultural, chemical, and biological control methods to suppress pests while preserving insect parasites and predators. Insecticides are not used until pest numbers reach crop-damaging levels. They are used judiciously and selectively to suppress pest numbers with minimum damage to natural enemies or the environment.

This is not a new concept. It has been around for many years. However, it was not until the late 1960's and early 1970's, when it became apparent that insecticides were having adverse effects on many non-target organisms, that IPM was seen as a way to conserve both crop yields and quality of the environment. Concomitant with the banning of DDT in 1972, the U.S. Environmental Protection Agency and the National Science Foundation funded the first large national project to develop alternate methods to insecticides for crop protection. This project, entitled "Principles, Strategies, and Tactics of Pest Population Regulation in Major Crop Ecosystems," and known as the Huffaker project for its Director, Dr. Carl Huffaker of the University of California-Berkeley, brought together more than 250 scientists from 18 major land-grant universities to develop IPM systems for six major crops.

The Huffaker project was the first to take a holistic approach to crop protection using the methods of the system scientists and the computer specialists to design research models that simulate the growth process of plants and the insects and mites that attack them. This project integrated the various components of crop protection, crop rotation, pest-resistant varieties, biological control, and insecticide treatments into unified, integrated management systems designed to minimize the use of chemicals.

The Huffaker project was funded from 1972 through 1978. It was succeeded in 1980 by a project organized by the Consortium for Integrated Pest Management (CIPM). CIPM is a consortium of 16 major land-grant universities that has used the knowledge and methodologies developed in the Huffaker project to focus on all the pests, insects, diseases, weeds, and nematodes of four major crops (alfalfa, apples, cotton, and soybean). CIPM was funded by the Environmental Protection Agency during 1980-1982. In 1982, funding was transferred by OMB to the USDA/CSRS. The project will be terminated early next year.

The CIPM project built on the systems approach developed by the Huffaker project. In addition, more emphasis was placed on the breeding for pest-resistant crop varieties and the use of economic models to analyze the impact of the new technology. Also, formal linkages were established with the Cooperative Agricultural Extension Service in an attempt to shorten the lag time between the development of a new control tactic and its implementation by farmers.

The Extension Service has done an excellent job in training farmers in the use of IPM and in the development of field scouting services. I believe most crop producers in the U.S. are aware of IPM.

Many critics of IPM say that it is an ivory tower approach to crop protection that has not been implemented on any large scale. Facts prove the contrary. IPM has proven to be a very profitable way for farmers to protect their crops and it has been implemented on a large scale.

Cost/benefit analysis in Texas shows that net returns to an individual cotton farmer may be increased from $25 to more than $100 per acre through the use of IPM. The annual economic impact to the state of IPM on cotton exceeds $300 million per year. In the northeastern U.S., IPM has produced savings to apple growers of $25 to more than $100 per acre, primarily through the reduced use of pesticides. In the north central region, the net returns to alfalfa producers may be increased by as much as $25 per acre and insecticide use reduced by 75%. In California, IPM methods may increase the life of alfalfa stands by a year. This accomplishment in itself will more than repay all the state and federal funds expended on IPM.

In terms of environmental quality and saving to farmers, recent USDA statistics show that from 1971 to 1982, insecticide use on cotton has been reduced from 73.4 million to 16.9 million pounds; on grain sorghum from 5.7 to 2.5 million pounds; and on peanuts from 6.0 to 1.0 million pounds. I believe these data show that we have been successful in developing IPM programs that minimize the use of insecticides and that they have been implemented on a large scale.

Economic analysis has been widely used in IPM research to demonstrate the cost/benefits of the emerging new technology when compared with the old. In fact, the CIPM project is the only large crop production research project, to my knowledge, which included an economic research unit in every crop research team. In addition, until recently the USDA Economic Research

Service had a substantial group involved in pest management research. As mentioned previously, cost/benefit analysis has been extremely valuable in getting farmers to adopt IPM practices.

In IPM the priorities for research and extension primarily have been established by the research scientists and extension specialists working in the field. They have been aided by farmer advisory groups and pest management associations. In addition, they have used the techniques of the system scientist to develop computer models of the system which identify knowledge gaps that should be filled. The computer models have been able to simulate the growth processes of the plants and the impact of pests and other environmental factors on these processes. These techniques have been highly successful in guiding this research and in allocating and reallocating funds to areas of highest priority.

There is still much research that needs to be done in IPM. We should continue the momentum produced in the Huffaker and CIPM projects by maintaining their unique organizational structure for managing complex, multidisciplinary research involving several states, the system-oriented research teams that are in place, the teams of economists that are working on cost/benefits of IPM as related to crop production and environmental quality, and by keeping in place the linkages between IPM researchers and the Cooperative Extension Service pest management programs. Unfortunately, it appears that this momentum will be lost when the CIPM project terminates next year.

There are many new areas of research that can benefit crop protection. The emerging biotechnology may provide a way to develop new crop varieties that are resistant or less attractive to pests, that better withstand environmental stress, and that are resistant to certain herbicides. It may allow us to clone pesticide-resistance genes into insect parasites and predators, conferring on them resistance to pesticides to which their hosts are susceptible. Biotechnology should allow us to produce more virulent strains of insect pathogens and highly selective biological pesticides.

There is much more conventional research that is needed on multi-pest interactions, insect forecasting, environmental modeling, computerized decision-making, and development of new biological and cultural control methods. Also, there is great need for more research on selective use of pesticides to minimize the development of pesticide-resistant pest strains.

Unfortunately, in spite of the results produced to date and the need to continue the above research in a highly coordinated, unified way, IPM is no longer a high priority item with federal budget makers. Allocations for IPM have not been included in recent USDA/CSRS or FES budget submissions. Indeed, they have been replaced by Congress at the request of producers and the scientists involved in IPM projects. In my opinion this is something that should be corrected. Some provision should be made in the USDA, EPA, or the National Science Foundation for the funding of large consortium projects where our universities can combine the nation's best scientific talent to conduct research on large national projects that require large multidisciplinary resources not available in any single institution. In summary, we need to develop some new models for managing agricultural research in this country. The CIPM model is one that has been highly successful, but is not likely to be continued.

Revised 6/8/84

Testimony of Dr. J. B. Weber
Before the U.S. House of Representatives
Committee on Agriculture, Subcommittee on Department Operations,
Research, and Foreign Agriculture
Hearings on Agricultural Research, Extension, and Higher Education
June 7, 1984

Credentials:

Mr. Chairman:

My name is Dr. Jerome B. Weber. I am presently a Professor in the Crop and Soil Science Departments at North Carolina State University in Raleigh, North Carolina.

My responsibilities include teaching a graduate course and conducting research on the behavior of pesticides and other toxic organic chemicals in plants and soils. I received my undergraduate education in agricultural engineering at the University of Minnesota and my Ph.D. in soil science and chemistry at the same institution. My position was created by funds from state and federal sources initiated by the appearance of Rachel Carson's book Silent Spring. My initial duties were to investigate the processes involved in the fate and behavior of herbicides in the environment. I was, in effect, to be the "devil's advocate" with respect to the environmental safety of agricultural pesticides. For the past 22 years I have carried out this assignment and have published over 100 research publications in scientific journals and books.

My consulting activities have taken me to many countries and have involved environmental problems caused by toxic organic chemicals including pesticides.

My areas of expertise includes reactions of pesticides with soil colloids; the mobility of pesticides in soils and water; determinations of the chemical properties of organic toxicants; degradation of pesticides in plants and soils; and the biological availability of toxic organic chemicals in soils.

Testimony

It is my understanding that I am to provide the members of this committee with information concerning the environmental safety of pesticides and future needs and opportunities. To do this I have asked myself eight essential questions concerning pesticides. They are as follows:

1. Why has the question of the safety of agricultural chemicals in the environment arisen?
2. What is the status of our present knowledge concerning the fate and behavior of pesticides in the environment?
3. What principles govern the fate and behavior of pesticides in the environment?
4. How does one evaluate pesticide safety in the environment?
5. Are the pesticides that are presently being used safe to the environment?
6. Are pesticides having an adverse effect on soil fertility?
7. How do pesticides fit into agricultural production systems like conservation tillage and organic farming?
8. What needs to be done to assure that pesticides are not adversely affecting the environment?

I will attempt to provide you with my answers to these questions and I will be citing approximately 100 references as documentation.

The first question "Why has the question of the safety of agricultural chemicals in the environment arisen?" may be apparent to many, but it is particularly important to me because it created the position which I now hold and it is an important part of my career. It also reflects on the ethics and integrity of the agricultural community of which I am a member.

For most people, the question of pesticide safety probably began in 1962 with the publication of Rachel Carson's book Silent Spring and with the multitude of environment-oriented books which followed. For me personally, it began in 1956 when Professor Alfred C. Caldwell of the University of Minnesota suggested that his soil science class, of which I was a member, read a book by Edward H. Faulkner entitled Plowman's Folly. The object of the book was to show that the moldboard plow was quote "the least satisfactory implement for the preparation of land for crop production." Students reacted to the book with mixed feelings. Most were farm boys who knew the benefits of the plow and did not like criticism of it. Faulkner's error was that he criticized the plow when his major attack should have been directed toward the way it was used. Inverting the soil with the plow destroyed the protective barrier of surface mulch and encouraged soil erosion by wind and water. Modifications of the plow to allow for a trash strip and the development of soil conservation practices such as terracing, strip cropping, and the use of grass waterways corrected most soil erosion problems, so the plow was really not the culprit. It was the way it was used. Unfortunately, many modern farmers have drifted away from conservation farming and the problems of soil erosion have reappeared. I address this issue later. As I stated previously, Rachel Carson pointed out the environmental problems being created from the use of pesticides. However, unlike Faulkner and his direct attack on the plow, Carson did not content that pesticides never be used but rather that the chemicals were not being used properly. She contended that "we have put poisonous and biologically potent chemicals indiscriminately into the hands of persons largely or wholly ignorant of their potential for harm. We have subjected enormous numbers of people to contact with these poisons, without their consent and often without their knowledge."

She blended fable with fact and used attention getting terms such as chain of evil, deadly films, chemical death rain, elixirs of death, and shadows of sterility to make her point. Miss Carson accurately stated that "we have allowed these chemicals to be used with little or no advance investigation of their effect on soil, water, wildlife, and man himself." But she also made some inaccurate statements, such as "under primitive agricultural conditions the farmer had few insect problems" and "This pollution (the pesticides) is for the most part irrecoverable; the chain of evil it initiates not only in the world that must support life but in living tissues is for the most part irreversible." She made excellent recommendations including the need for basic knowledge in ecology, toxicology, soil science, and weed science, emphasis on biological and mechanical pest control methodology, better marked and safer pesticide containers, increased monitoring for pesticides, and increased education regarding pesticides. Her book stimulated President Kennedy's Scientific Advisory Committee to prepare an extensive report on the Use of Pesticides. The Committee made many worthwhile recommendations, many of them taken from Carson's book. Two years after Silent Spring, another book entitled Pesticides and the Living Landscape by Robert L. Rudd was published. Rudd examined the effects of pesticides on nature through an extensive review of pesticide literature. He reported that the effects of pesticides on the environment were less damaging and less permanent than Rachel Carson had suggested and stated "whatever the immediate consequences of toxic chemicals in the living landscape--and they are sometimes serious--it must be said that they are normally correctable." He recommended the use of integrated pest management strategies and more active coordination and cooperation among governmental agencies.

In 1966, hearings were held before a subcommittee of the Committee on Appropriations, House of Representatives, on Department of Agriculture Appropriations. A report entitled "Effects, Uses, Control, and Research of Agricultural Pesticides" was published. The report dispelled some of the alarm set off by Rachel Carson's book. The report was followed by Committee Chairman Jamie L. Whitten's book That We May Live which further examined the contentions of Rachel Carson. The book also aided in dispelling some of the alarming claims made in Silent Spring.

Scientists at a scientific conference held in Rochester, New York, in 1968 discussed current research on persistent pesticides and published a book entitled Chemical Fallout. Two important issues emerged from the conference. The first was that pesticides and other agricultural chemicals made up only part of the pollutants which were contaminating the environment. The second was that polychlorinated biphenyls (PCBs), which were related to DDT were also being found in wildlife and were also having adverse effects on the environment. Barry Commoner in his book The Closing Circle brought the same message to the public in layman's terms.

Eight years after the appearance of Silent Spring, Frank Graham, Jr., published Since Silent Spring wherein he reviewed what had been accomplished in understanding and controlling pesticides since Rachel Carson's book had appeared. Graham described the pressures of the chemical and agricultural interests against control of pesticides, contradictory and ineffective policies of government agencies, and the tunnel-vision of technical people who worked with pesticides and failed to heed the possible effects of their work beyond the narrow research targets they had set for themselves.

Not all writers assessed the dangers of pesticides in the same way as did Rachel Carson. Rita Beatty in her book *The DDT Myth* concluded that many of the adverse environmental effects that were being attributed to pesticides, especially DDT, were the result of other changes that man was imposing on the environment. She recommended extensive increases in federal funds be made available to the land-grant colleges and universities for large-scale and continued experimentation and testing of agricultural pesticides and fertilizers, that both state and federal governments establish agricultural review boards, and others.

James Whorton in his book *Before Silent Spring* examined the problem of food adulteration by insecticides before DDT was discovered. His book was critical of the use of agricultural chemicals by farmers and technical agriculturalists.

Maurice B. Green in his book *Pesticides -- Boon or Bane?* examined the benefits of pesticides to the national economy and weighed them against the risks of possible harm to the environment. He advocated the use of cost-benefit analysis to determine what restrictions or prohibitions should be placed on the use of a particular pesticide. Since he worked for both the university and chemical industry, the objectivity of his book was questioned by many.

Robert Van Den Bosch in his book *The Pesticide Conspiracy* wrote critically of the ethics of the technical community who worked with pesticides and he strongly advocated integrated pest management as the ultimate means of pest control.

Thomas Whiteside in his books *Defoliation* and *The Pendulum and the Toxic Cloud* described the effects to man and the environment of herbicides and toxic contaminants contained in the herbicide formulations. He questioned the ethics of the manufacturers of pesticides.

One of the most recent books concerning pesticides in the environment is Michael Brown's book Laying Waste in which he describes the adverse effects to the environment of toxic wastes, including pesticides, that were disposed of in waste disposal dumps. He attributed most of mankind's maladies to exposure to the chemicals and questioned the ethics of the producers of industrial chemicals. In addition to popular books attacking pesticides used in agriculture, several others, including Jim Hightower's book Hard Tomatoes; Hard Times have lowered the public's credibility of agricultural experts, in particular the land-grant colleges and universities. Newspaper articles reporting adverse effects of pesticides are common although in most instances they are based on limited information. Basic research on pesticide fate and behavior in the environment is still inadequate, especially with regards to the long-ranged effects of pesticides in the environment.

Question 2. What is the status of our present knowledge concerning the fate and behavior of pesticides in the environment?

In order to evaluate the charges and counter charges made against pesticides by the many books previously mentioned, scientists and scientific organizations have evaluated and assessed thousands of research studies involving pesticides dissipation in the environment. The results are the following:

1. There are at least a half dozen books that are updated annually which describe the chemical properties and uses of pesticides. In addition, there are at least a dozen books which discuss the chemistry and toxicology of pesticides. Examples are listed in the Reference Section under Pesticide Chemistry.

2. At least 20 books have been published which evaluate the fate and behavior of pesticides in the environment. They are listed in the Reference Section under Pesticides in the Environment.

3. Approximately a half-dozen books have assessed the ecological effects of pesticides and are listed under that title in the Reference Section.

4. At least 15 books have been published concerning the chemical action of pesticides on organisms. These are listed under the Biochemical Action of Pesticides in the Reference Section.

5. At least a half-dozen books have been published on pest control with methods other than chemicals. Examples are listed under Pest Control Strategies of the Reference Section.

6. Innumerable books are now available on analytical methods for pesticide determinations. Examples are listed under Pesticide Analytical Methodology of the Reference Section. Pesticide concentrations in amounts as small as parts per trillion and lower are now possible.

Hundreds of references are cited in these books. The overwhelming evidence is that the pesticides which are presently being used probably do not cause significant long-ranged detrimental effects on the environment. However, as was stated previously, basic information on the long-ranged effects of pesticides on the environment is limited, so the ultimate answer must remain unanswered.

Question 3. What principles govern the fate and behavior of pesticides in the environment?

The fate and behavior of pesticides in the environment is dependent on many processes some of which take place simultaneously and on the chemical properties of both the pesticides and the media in which they reside (Weber, 1972; Weber et al., 1973; Weber, 1974). Pesticides are involved in many processes including reactions with soil particulate matter; absorption, degradation, accumulation and/or exudation by organisms; degradation by sunlight or by chemical reactions; volatilization into the atmosphere; dissolution and movement in leaching waters or in runoff waters.

Pesticide behavior is regulated by the properties of each specific pesticide, the properties of the soil environment, and the climatic conditions which prevail (Weber, 1972; Weber et al., 1972; Weber, 1977; Weber, 1984). The important properties of the pesticides include: (1) Relative stability (persistence/or half-life) of the compounds; (2) Ionization potential (overall ionic charge; positive, negative, or noncharged); (3) Water solubility; (4) Volatilization potential (vapor pressure at ambient temperature); and (5) Presence of complexing groups (phosphorus, arsenic, etc.).

The important properties of the soil environment include: (1) Type and quantity of soil constituents (organic matter, clay minerals, and metallic hydrous oxides); (2) Soil pH level; (3) Types and concentrations of other solutes (nutrients, natural products, etc.); and (4) Types and numbers of soil organisms.

Pesticide Properties

With regard to the relative stability or longevity of pesticides, the only chemicals presently being used widely in agriculture are those that have been shown to be relatively non-persistent, in accordance with federal pesticide regulations. There have been some exceptions to this where normally non-persistent chemicals became persistent due to specific local conditions; e.g., aldicarb (Temik), an insecticide with no ionizing properties, high water solubility, and moderate to high vapor pressure was leached through the very sandy soils of Long Island, New York, and found its way into the ground waters where it contaminated the drinking water in numerous wells. The stability of aldicarb in the underground waters was much longer than observed in surface waters or in agricultural soils. The chemical is no longer registered for use for such situations. Another example was the fumigant EDB (ethylene dibromide), which has chemical properties much like aldicarb and which under certain conditions was found to be much more mobile and stable than previously thought. There are other commonly used pesticides which under the right conditions might be expected to present environmental problems. Among these would be industrial herbicides which have long half-lives, are either nonionizable or ionize to form anionic species, and which possess high water solubilities. Under the right conditions, i.e., high rainfall, coarse textured soil, these chemicals can be expected to get into underground waters.

Since the majority of pesticides presently being used are of the nonpersistent variety, their behavior in the environment is dependent upon the remaining four chemical properties. It should be said at this point that many scientists are presently developing models to predict pesticide behavior in the environment, but unless these four key properties are utilized in the model equation, the models have little chance for success. The most important chemical property is ionization potential since this determines whether the chemical has an overall positive or negative charge or is noncharged. Positively charged pesticides, such as the herbicides diquat and paraquat, are readily bound to soil colloids through ionic bonds. The compounds are thus immobile in soil. The fact that these chemicals are very highly water soluble is no longer relevant in predicting their mobility in soil. Pesticides which possess basic properties, such as the triazine and triazole herbicides, can also form cationic species in soils depending upon the ionization constant of the chemical and the pH of the soil solution. Thus, under acidic conditions basic pesticides may become protonated (positively charged) and relatively immobile in soil (e.g. atrazine is relatively immoble in the acid soils of the Southern U.S.), whereas under basic or neutral pH conditions the chemicals remain in the molecular (noncharged) form and may be mobile (e.g. atrazine can be leached into the high pH soils of the Midwest U.S.). Their mobility under the high pH conditions is then primarily dependent on the water solubility of the chemical. Pesticides which possess acidic properties, such as the phenoxy acid herbicide 2,4-D and the picolinic acid herbicide picloram normally ionize to form negatively charged (anionic) species which are highly mobile in the soil and water. Under acidic conditions, depending on the ionization constant of the chemical, a portion of the acid chemicals will be present in the uncharged (molecular) form. The uncharged species are generally less mobile than the negatively charged species in most soils. An exception might be the case in soils with high anionic exchange capacity, such as the high iron and aluminum containing soils of the tropics and semi-tropics.

Water solubility is the key chemical property which regulates behavior of nonionic chemicals which do not possess complexing-type functional groups. This includes a great many families of pesticides such as the chlorinated hydrocarbons(aldrin), carbamates aldicarb (insecticide) and chloropropham (herbicide), acetanilides (alachlor), phenylureas (diuron), and dinitroanilines (trifluralin). The relative mobility of these chemicals in soils is highly realted to their water solubility. A water solubility classification scheme that is useful for characterizing pesticides is as follows:

Category	Description	Water solubility (ppm)
1	Very highly soluble	Greater than 10,000 (1%)
2	Highly soluble	1,000 to 10,000
3	Moderately soluble	100 to 1,000
4	Low solubility	10 to 100
5	Very low solubility	1 to 10
6	Extremely low solubility	Less than 1

Volatilization potential as expressed by the vapor pressure of a chemical is an important property for predicing the mobility of a pesticide in the vapor state. It is particularly important for predicing the relative movement of a pesticide like EDB which is highly mobile because it has both high vapor pressure and high water solubility. A useful classification scheme for characterizing the volatilization potential of pesticides is as follows:

Category	Volatilization Potential	Vapor pressure at at 20-30°C (mm Hg)
1	Very highly volatile	Greater than 10^{-3}
2	Highly volatile	10^{-4} to 10^{-3}
3	Moderately volatile	10^{-5} to 10^{-4}
4	Low volatility	10^{-6} to 10^{-5}
5	Very low volatility	10^{-7} to 10^{-6}
6	Extremely low volatility	Less than 10^{-7}

If a pesticide contains complexing groups such as arsenic, present in the arsenical herbicides DSMA and MSMA, or phosphorus, present in the herbicides glyphosate and fosamine, the chances are it will be very immobile in soils because such groups readily complex to clay mineral surfaces. If a pesticide does not contain such complexing groups, its movement in soils will be dependent on the chemical properties previously mentioned. The ultimate behavior and fate of a given pesticide in the environment depends on consideration of each of the above listed properties, in conjunction with the properties of the media and climatic conditions.

Soil Properties

Pesticides which ultimately end up in the soil behave not only according to the properties of the chemicals themselves, but also according to the particulate matter with which they come in contact. Soils contain mixtures of sand, silt, clay, organic matter of various kinds, and metallic hydrous oxides. It is the latter three components which because of their small particle size and active surface chemistry exert the greatest effect on pesticide behavior. Clay minerals, because of their high surface area and negative charge properties readily interact with positively charged pesticides, pesticides with basic properties and/or pesticides which possess complexing-type functional groups, and, to a lesser extent, pesticides which have at least some polar characteristics. Clay minerals react with and retain to only a limited degree pesticides which are nonpolar and/or which are relatively volatile. Organic substances, particularly those such as humic matter which have both lipophilic (fat living) and hydrophilic (water living) sites and cation exchange sites readily interact with and bind all pesticides, at least to some degree. Cationic pesticides bind to the exchange sites, basic pesticides react with undissociated acid groups, and acidic pesticides and nonionic pesticides bind to lipophilic and hydrophilic sites depending on the water solubility of the pesticide involved. Metallic hydrous oxides bind negatively charged pesticides to a greater degree than other pesticides but their contribution to pesticide inactivation is probably only important in the "red" tropical and semi-tropical soils.

Soil pH influences pesticide behavior because it regulates the equilibrium between ionized and molecular species of ionizable pesticides and hence the amount adsorbed and biologically available at any given moment. Soil pH also regulates the type and quantities of microorganisms present and thus influences the decomposition of pesticides that are degraded biologically.

Many other natural products and nutrients present in soil influence pesticide behavior by competing for adsorption sites on colloidal surfaces and/or by providing energy for microbial growth.

The type and numbers of soil microorganisms governs to a great extent the longevity of specific pesticides. Bacteria, fungi, and actinomycetes have all been shown to degrade certain types of pesticides and when the proper organism is present in sufficient numbers degradation of a given pesticide occurs rapidly and completely. However, when the right organism is not present or not present in sufficient numbers, a given pesticide may endure for a much longer period of time than normal. Microbial activity is regulated by temperature, moisture, nutrient status, soil pH and other factors. Normally, microbial activity and microbial degradation of pesticides is highest under warm, moist conditions and lowest under cool, dry conditions. This is why pesticides which may not last through the entire growing season in southern U.S. soils occasionally persist into the following year in northern U.S. soils. Differing soil types and soil factors, such as difference in soil pH, also influence the longevity of pesticides at different latitudes.

Question 4. How does one evaluate pesticide safety in the environment?

Basically this could best be done by assessing all that is known about a particular pesticide and comparing it with other well-defined compounds. This bank of knowledge would include the following: (a) key chemical properties, (b) methods of use, and (c) biological and environmental properties.

The key chemical properties were discussed previously and include: (1) relative stability, (2) ionization potential, (3) water solubility, (4) volatilization potential, and (5) presence of complexing groups.

The methods of use of pesticides would be characterized by one of the following: (1) applied broadcast to growing crops (postemergence), (2) applied broadcast to soils (preemergence or preplant incorporated), (3) applied locally around foundations (termicides), or on industrial sites (sterilants), or (4) applied to inland waters.

Biological and environmental properties would include: (1) mechanisms of action, (2) degradation pathways, (3) longevity in air, soil, and water,

(4) edaphic (soil) behavior, (5) toxicological properties, and (6) bioaccumulation potential.

Question 5. Are the pesticides that are presently being used safe to the environment?

Considering the extensive and critical evaluation of pesticides in the environment by both scientists and nonscientists alike as exemplified by the nearly 200 books published and cited in the Reference Section of this testimony, one would have to conclude that although some environmental problems occasionally occur, pesticides by and large are environmentally safe to use. It is true that some of the early pesticides, such as the chlorinated hydrocarbons and the toxic heavy metal compounds did have adverse effects on the environment. These materials have been removed from the marketplace or are registered for restricted use only.

It is not possible for me to provide the members of these hearings with an iron clad, 100% guarantee of the environmental safety of all presently used pesticides. There are three reasons for this. First, the basic research on the long-ranged effects of pesticides on the environment has not been carried out and thus is not available. Second, I do not have access to much of the information regarding the properties of all pesticides as was suggested in Question Number 4. Much of this information is of a proprietary nature and thus is not available to the public. Third, I did not have time to adequately examine much of the information that was available.

The best that I can do is to compare the relative environmental toxicity of a sizeable number of presently used pesticides using a scheme that I developed about eight years ago and which I published in the Journal of Environmental Science and Technology (Vol. 11, pages 756-761, 1977). The scheme is based on only four key factors. They include: (1) acute oral toxicity to rats, which gives an indication of their mammalian toxicity, (2) acute oral toxicity to the most sensitive fish species tested, which gives an indication of toxicity to aquatic wildlife, (3) longevity in soil, which gives an indication of how long the chemical has to react with the environment, and (4) bioaccumulation by aquatic organisms which gives an indication of the biomagnification potential in wildlife. The relative environmental toxicity of a selected group of 72 commonly used pesticides is presented in Table 1 using my scheme. The most environmentally toxic chemical would have a value of 16.0. A chemical with the lowest toxicity would have a value of 4.0. The mean value for the chlorinated hydrocarbon insecticides is 13.9 with a range of from 12.6 to 15.3. These chemicals have been discontinued or are restricted-use materials. All of the other presently used pesticides have much lower environmental toxicity values ranging from 4.4 to 10.4. The organophosphorus insecticides have somewhat higher values than the other pesticides and have a mean value of 8.4, as compared with mean values of 6.7 for the others.

Does this mean that the presently used pesticides are environmentally safe? Not exactly. What it means is that the old pesticides that were implicated in environmental problems have environmental toxicity values two to four times those of the more recently developed chemicals which are in present use. This scheme does not allow for an evaluation of all long-ranged adverse effects which might occur.

To allow for a more accurate comparison, one would need to compare all of the chemical, biological and environmental properties of all pesticides. Unfortunately, neither the information nor the time was available for these hearings. It is a task, however, that I feel should be done and once it is done, articles should be prepared by experienced scientists in cooperation with

Table 1. Relative environmental toxicities of selected pesticides.

Common name*	Rating**
Chlorinated hydrocarbon insecticides	
Aldrin	14.4
Chlordane	12.6
DDD	12.9
DDT	14.4
Dieldrin	14.1
Endrin	15.3
Heptachlor	14.5
Kepone	13.3
Mean value	13.9
Organophosphorous compounds	
Bensulide (h)	8.3
Diazinon (i)	8.0
Dichlorvos (i)	8.0
Dimethoate (i)	7.3
Disulfoton (i)	9.3
Fenchlorphos (i)	6.8
Fenitrothion (i)	8.3
Imidan (i)	7.8
Leptophos (i)	8.5
Malathion (i)	7.2
Mevinphos (i)	9.5
Parathion (i)	10.4
Phorate (i)	10.1
Mean value	8.4
Carbamates	
Asulam (h)	4.4
Carbaryl (i)	7.9
Carbofuran (i)	10.2
Cycloate (h)	6.4
Diallate (h)	6.8
Eptam (h)	5.9
Molinate (h)	7.2
Pebulate (h)	6.0
Mean value	6.9
Triazine herbicides	
Ametryn	6.5
Atrazine	7.8
Cyanazine	7.3
Metribuzin	7.2
Prometon	8.5
Simazine	6.3
Mean value	7.3

Table 1 (continued)

Common name*	Rating**
Organic acid herbicides	
Acifluorfen	6.3
Bentazon	5.4
Bromacil	6.0
Bromoxynil	7.8
Chloramben	4.7
2,4-D	7.2
Dalapon	4.9
Dicamba	5.7
Dinoseb	8.5
Endothall	7.6
Fenac	8.6
Ioxynil	7.1
Picloram	7.9
2,4,5-T	8.9
Terbacil	6.7
Mean value	7.0
Acetanilide herbicides	
Acetochlor	6.7
Alachlor	6.6
Butachlor	6.8
Metolachlor	6.4
Mean value	6.6
Phenylurea herbicides	
Diuron	6.7
Fluometuron	5.7
Linuron	7.7
Mean value	6.7
Miscellaneous herbicides	
Amitrole	5.4
Buthidazole	5.9
Chlorsulfuron	5.0
DCPA	5.2
Dichlobenil	7.6
Dinitramine	6.5
Diphenamid	6.4
Ethalfluralin	6.5
Fluridone	6.9
Fluazifop-butyl	6.4
Glyphosate	5.6
Hexazinone	6.8
Methazole	6.1
Pyrazon	5.6
Tebuthiuron	7.3
Mean value	6.2

*h = herbicide: i = insecticide

**Maximum toxicity = 16.0; minimum toxicity = 4.0

authors of popular articles. These articles, if put into the popular press, would help to inform the governmental leaders and the public about the environmental safety of pesticides.

Question 6. Are pesticides having an adverse effect on long-ranged soil fertility?

A newspaper article in the Dallas Morning-News by David Hanners says that "Pesticides may damage soil, but farmers forced to use them." The article cites Dan Langford, a Texas cotton and wheat farmer, who says that pesticides are killing the soil. It cites Ron Carroll, assistant director of Environmental Studies at Baylor University, as saying that pesticides may be seriously damaging the delicate chemical composition of the soil and reducing long-term soil productivity. In the same article, Jim Hightower, Texas Agriculture Commissioner, states that pesticides poison the land and mess up Mother Nature. An unidentified entomologist states that amounts of chemicals have dramatic effect on the chemical composition of the soil. Steven Risch, Assistant Professor of Entomology at the University of California at Berkeley, said that there is quite a bit of evidence to show that long-term use of pesticides affects the microorganisms in the soil and the breakdown of organic matter is changed. This article is typical of many that I have read over the past 22 years. I have asked myself many times are these claims valid? Where is the evidence? I have searched the literature for evidence to backup the claims stated above but I have been unable to find any and I can only conclude that the claims are based primarily on speculation. Because of the limited basic research on the long-ranged affects of pesticides on soil fertility, perhaps the speculation is justified. The hundreds of articles that I have examined and the numerous books published by experts in the field suggest that pesticides which are presently being used are as safe to the environment as commonly used pharmaceuticals are to human health. For both examples, misuse can lead to disaster, and proper use can lead to great benefits. The large gaps in our knowledge of long-ranged affects of pesticides might also eventaully lead to environmental disasters similar in scope to the effects of DDT on the reproduction of certain wildlife.

Soil fertility is defined as the capability of sustaining abundant plant growth. Thus, chemicals which affect soil fertility might affect one or more of a number of processes.

Because they are normally applied to soils at much higher rates, and because they are generally designed to affect microbial populations, fungicides and fumigants generally have much greater and lasting effects than herbicides or insecticides. The effects, however, are not irreparable and soil microbial populations return to normal after 2 or 3 months.

DDT and other chlorinated hydrocarbon insecticides, and organophosphorus insecticides have shown little effect on bacteria, fungi or actinomycetes. In a few cases, nitrate production was decreased slightly but ammonification was generally stimulated. No effects on nodulation of legumes were observed except at excessively high rates (10 to 40 times normal field rates). The organophosphorus insecticides normally stimulated soil respiration primarily because they provided energy to soil organisms which degraded them.

Few herbicides have any great or prolonged adverse effects on the microbial component of the soil. Individual microbial species are frequently decreased in numbers but the effects do not appear to be permanent. The usual decrease in numbers is normally followed by an increase in numbers. Such effects are due to a disruption of the rhizosphere and non-rhizosphere organisms by the killing of the vegetative cover followed by an increase in microbial population during the decomposition of the dead plants. Some herbicides (trifluralin, MH, dalapon, 2,4-D) promote certain fungal diseases (damping off, wilt, early blight), and others (diuron, dinoseb, propham, TCA, trifluralin, MH, dalapon) suppress certain other fungal diseases (root rot, wilt, early blight). However, a large number of herbicides stimulate the populations of the fungus Trichoderma viride, a species which suppresses many pathogenic fungi.

Pesticides have been shown to affect the populations of soil bacteria, fungi, and actinomycetes, ammonification, nitrification, dinitrification, and N_2-fixation processes, rhizobia and legume nodulation, free-living organisms, soil pathogens and their antagonists, algae, cellulolytic activity and organic matter degradation, respiration activity, and other enzymatic activity. Most chemicals, even at normal rates, have some form of effect on microbial activity. In most instances, the effects noted are transient, lasting a few days or a few weeks.

It should be pointed out that soil microflora are responsbile for 90% of the biolgoical respiration activity in the soil and that these microoranisms are very resilient. Re-colonization of pesticide treated soils does eventually occur in all cases. There is little evidence to show that pesticides have produced or are producing any long-ranged adverse effects on the many soil processes on which soil fertility depends. There is also little evidence to show that they are not. There is an abundance of short-ranged evidence to show that the pesticides which are presently in use are not adversely affecting soil fertility and offer a great many benefits at very minimal risk.

Question 7. How does pesticide use fit into agricultural production systems like conservation tillage and organic farming?

With the renewed interest in conservation tillage (otherwise known as no-till, minimum-till, and reduced-till), in order to conserve fuel and minimize soil erosion and water losses, pesticides must fit or new pesticides must be developed to fit. This renewed interest in conservation tillage and the use of good soil conservation practices is a step in the right direction.

Farmers ought to be encouraged and offered financial inducements to use these practices because both the soil and agricultural chemicals ought to be kept on the land. Pesticides in conjunction with other pest control methods will be as necessary for the continued production of crops in all cropping systems as pharmaceuticals are for the continued maintenance of human and animal health.

Question 8. What needs to be done to assure that pesticides are not adversely affecting the environment?

It is my opinion that several tasks need to be carried out to ensure a high margin of safety regarding pesticides and the environment. First, industry should be encouraged to complete the characterization of the chemical, biological, and environmental properties of each of their respective pesticides. Second, objective, basic research on the long-ranged effects of pesticides on the environment, particularly on the soil microflora, should be carried out at universities and colleges to assure the long-ranged environmental safety of pesticides. Third, governmental agencies like the Environmental Protection Agency should be encouraged to assemble this information into a handbook somewhat similar to Karel Verschueren's environmental handbook for organic chemicals. Fourth, this information should be used to prepare "newsy" articles for the public regarding the environmental safety of pesticides. Fifth, research should be initiated to develop a much more accurate soil test on which to base pesticide rate recommendations. The new test should thus become standard in all soil testing laboratories. The present use of soil organic matter content, as determined by differing and unstandardized methods, and used in conjunction with soil texutre is wholly inadequate. A new, accurate soil test would assure that pesticides would be applied at optimum rates which control the target pest most economically and then dissipate safely. Sixth, university soil science departments should be encouraged to initiate new research projects that delve deeply into the basic chemistry of soil humic matter and examine potential benefits from added organic substances which are present or which are added to soils. The soil organic matter project hsould also examine any benefits which might be derived from the organic farming philosophy. Organic matter added to soil has long been known to have beneficial effects on soil structure, aeration, water holding capacity and other soil parameters. Its merits and costs should be seriously examined.

(Dr. Jerome Weber's curriculum vitae is held in the subcommittee files.)

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HIGHER EDUCATION ISSUES, EXTENSION ACCOUNTABILITY, FORMULA CHANGE, AND COMPUTER TECHNOLOGY

TUESDAY, JUNE 12, 1984

House of Representatives,
Subcommittee on Department Operations,
Research, and Foreign Agriculture,
Committee on Agriculture,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:40 p.m., in room 1302, Longworth House Office Building, Hon. George E. Brown, Jr. (chairman of the subcommittee), presiding.

Present: Representatives Penny, Volkmer, Olin, Roberts, and Gunderson.

Staff present: Peggy L. Pecore, clerk; William A. Stiles, Jr., and Gerald R. Jorgensen.

OPENING STATEMENT OF HON. GEORGE E. BROWN, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. Brown. The subcommittee will come to order.

This afternoon, we are beginning the third day of hearings on research, extension, and higher education in agriculture. Today, the subcommittee will look at extension and higher education issues.

The subcommittee has conducted extensive oversight hearings on the Cooperative Extension Service. As a result of past hearings and other reviews, Extension developed the extension in the 1980's report. The report provided guidance to the very decentralized extension system on issues of national concern. This hearing will focus on three outstanding issues from this report: one, accountability and evaluation; two, computer technology needs; and three, alternatives for changing the Federal distribution formula.

Cooperative Extension has placed a high priority on improved accountability, on the use of resources, and better evaluation of program effectiveness. The subcommittee needs to understand the potential and limitations of the new accountability and evaluation system.

Acquiring computer expertise has been a high priority for extension, both in the extension in the 1980's report and as a continuing national budget priority. To date, appropriations have not been provided specifically for computer technology in extension. In part, this has been due to uncertainty about the unique role for extension in computer technology. Extension must identify what nobody else can do. The extension in the 1980's report called for a major extension role in packaging research findings into software for onfarm use. The possible interactions between extension and the private sector are complex and evolving. We will look particularly closely at alternatives for direct electronic transmittal of information and decision models to farmers, either through an extension or commercial videotex system.

We will also be interested in hearing about the review effort called for in the extension in the 1980's report to evaluate the need for a revised distribution formula. The current formula has been unchanged for over two decades. The primary weights placed on farm and rural population in the current formula may be no longer representatives of the broadened extension mission and clientele.

The subcommittee held 2 days of oversight hearings in February on higher education needs. Today's focus on higher education will serve to define more sharply the funding and information needs of the system if it is to meet the future demand for human resources. The strength of public research and extension institutions and our private agricultural industry depends on a sufficient number of high-quality graduates in the food and agricultural sciences.

I look forward to a full discussion of these issues, both today and tomorrow morning when the USDA policy officials will testify.

Does any other member desire to make any opening statement?

Mr. Penny. No.

Mr. Olin. No.

Mr. Brown. Our first witness this afternoon will be Dr. Lark Carter, dean of agriculture and natural resources, California Polytechnic State University, San Luis Obispo.

Dr. Carter, we are very pleased to have you here, and I look forward to your testimony.

STATEMENT OF LARK P. CARTER, DEAN OF AGRICULTURE, CALIFORNIA POLYTECHNIC STATE UNIVERSITY, ON BEHALF OF THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES AND AMERICAN ASSOCIATION OF STATE COLLEGES OF AGRICULTURE AND RENEWABLE RESOURCES

Mr. Carter. Thank you, Mr. Chairman. Would you please enter the full manuscript of my testimony in the record, and I will summarize some of the main points.

I appreciate being permitted to testify early, which will allow me to get home tonight to take care of commitments I have tomorrow.

As you mentioned, I am dean of the school of agriculture at Cal Poly, San Luis Obispo. Prior to taking that position, I served for 1 year as Assistant Director of the Office of Higher Education in the Department of Agriculture. Prior to that, as associate dean, I was assistant director of the ag experiment station at Montana State. This gives me three different perspective: land grant, non-land-grant, and USDA experience.

My testimony today will focus primarily on the issues of teaching or higher education in the food and agricultural sciences. I am pleased to have this opportunity to present testimony on the teaching aspects of providing professionals for what is Cal Poly's largest school and California's major industry, which is agriculture.

Teaching is the No. 1 priority at Cal Poly. We have research and we have service projects, and our faculty are involved in many of these things, but teaching is the number one priority. There will be about 3,700 students in our school of agriculture next fall. We just graduated over 800 this last Saturday. This makes Cal Poly one of the largest agricultural undergraduate programs in the Nation. I bring that to your attention to point out that there is a significant portion of the agricultural expertise that is being educated in this country that are not coming out of the land-grant universities. We certainly think the land-grant university is extraordinarily important, but so are these non-land-grant institutions.

Cal Poly is one of 65 of these institutions, and the organization that I represent here is AASCU, and the American Assocation of State Colleges of Agriculture and Renewable Resources. These non-land-grant and land-grant colleges of agriculture, in cooperation with the U.S. Department of Agriculture, comprise a vital working force of people with a very important mission, and that mission is to develop and maintain a productive, efficient and competitive American agriculture.

Title XIV of the farm bill recognizes the importance of the teaching component, along with research and extension. I would like to compliment Congress, this last year for the first time, for appropriating $5 million for the graduate fellowship program to attract capable, highly motivated students into professional areas in agriculture where human expertise shortages exist.

I was distressed, however, to learn that in the House markup this last week, it did not include funding for this program. It is extremely important that, as revisions are considered for title XIV of the farm bill, that the language continue to include teaching as an integral part of the legislation, along with research and extension. In addition, it is essential that appropriate language be retained, authorizing funding for the graduate fellowship program. I would also say that it is important that the language of this bill be written in such a way as to allow for support of both NASULGC and AASCARR institutions. Both groups of institutions are significant contributors to the agricultural expertise pool.

The Joint Council on Food and Agricultural Sciences assessed priorities this past year, and they established a string of about eight recommended priorities. I noticed that the second of those priorities was the scientific expertise development in the food and agricultural sciences. It appears to me that the Department has really not very adequately addressed the No. 2 priority. I think it deserves more attention.

As one looks at priority issues identified by the joint council, it is apparent that the need for continuing education opportunities for food and agricultural science faculty is becoming more and more important. For example, faculty who came through their educational training in 1964 probably did not learn how to operate a microcomputer. In fact, they probably did not even know how to type or operate a keyboard. This is only one example of the need that exists among midcareer faculty members for gaining new knowledge and skills to continue to be effective teachers as well as researchers or extension specialists. So, strengthening grants are going to have a greater and greater potential as a means of strengthening institutional capacities to respond to State, national, and international needs in the food and agricultural sciences.

These grants would be of particular importance to the AASCU agricultural colleges and universities which do not have the benefit of the Hatch Act and the Smith Lever Act funds.

The Higher Education Programs Office, Science and Education, USDA, should be commended for their efforts to develop a much-needed information system on higher education in agriculture. You will be hearing more about that in testimony later. Suffice it to say that FAEIS, the food and agriculture education information system, will for the first time provide accurate data on the total system of higher education in agriculture in the United States.

The revised farm bill should include authorization for support of this type of service.

I would like to address priority 3 from the national priorities of the joint council. The technology involved in gathering, analyzing, and disseminating information is developing at an extremely rapid pace. Both resident instruction and cooperative extension must become increasingly alert to the potential uses of modern computer technology and telecommunications for increasing agricultural productivity and efficiency within the total agricultural system.

The development of this new technology has created new opportunities for higher education in agriculture, which has also created problems for us to solve. A high percentage of the high school students coming to our campuses have already been exposed to and have experience with computers and are expecting to acquire more skills at the university. Most universities do not have a sufficient number of staff with the expertise that is needed to provide this education.

On the other side of the fence, the agricultural industry with which we work very closely, both at the land-grant and the non-land-grant institutions, expects us to come up with help for them. For example, at Cal Poly, we recently contracted with the California Milk Advisory Board to use the student interns in the field to collect data and create a database for that board. We have many requests for this kind of assistance, more than our faculty can respond to. We have the people with the expertise, but as a non-land-grant university, our extension funds are made available to provide these services. We do the best we can, usually on an overload basis for our faculty to serve these needs. We turn down more requests than we are able to respond to.

At Cal Poly, we are dealing with the transition to the information age in a number of ways. We are providing inservice computer education programs for high school vocational agriculture teachers throughout the State and through our vocational education programs unit, which is an oncampus supply house for visual aids and computer programs, we provide useful, workable, debugged software for vocational agriculture teachers in the high schools, and for the agriculture teachers in the community colleges.

There are about 800 high school teachers in California and there are 55 community colleges that offer agricultural programs in California. So this is a fairly sizable operation. The software has been developed in such a way that these teachers are able, after additional training which we provide, to teach computer skills at their schools.

The ongoing need is, then, for the development of additional software that has been screened by faculty with the appropriate expertise to assure that agriculture teachers at all levels are able to acquire and use professionally credible debugged easy-to-use software.

We find that our greatest constraint to progress in the general area of communication technology is the human resource constraint. We have used a number of things: Joint appointments between the school of agriculture and the computer science department to provide joint expertise with people with agricultural backgrounds and computer skills. Another way is to use faculty from the various agricultural disciplines to teach the beginning computer science course so that it frees the shortage of people with the theoretical skills in computer science for the upper level courses, and our people can teach those beginning level courses. In addition, our faculty are being encouraged to develop computer applications in their classes, either as a part of the existing courses or to develop new courses.

It appears that the need for teachers that are knowledgeable about computers and also knowledgeable about agriculture will have to be addressed, at least in the short run, by retraining or additional training of the existing faculty.

I would like to summarize with six recommendations. First, I recommend that language be retained in the revision of title XIV of the farm bill designating the USDA as the lead agency in the Federal Government for agricultural research, extension, and teaching in the food and agricultural sciences. Second, I recommend that any revision of title XIV of the farm bill include a continuation of authority to appropriate funds for strengthening grants and for graduate fellowships to support the teaching component of the agricultural research, extension, and teaching network. Third, I recommend that any revision of title XIV of the farm bill be written in such a way as to include AASCARR institutions as well as land-grant institutions as those eligible to receive support under this legislation. Fourth, I recommend that USDA continue to support the development, implementation, and continuation of the food and agricultural education information system. Fifth, I recommend that USDA work cooperatively with the State research, extension, and teaching units to address the higher priority issues that are identified by the joint council. Finally, I recommend that membership on the joint council continue to maintain a minimum of two representatives from the AASCU and AASCARR institutions which contribute so greatly to the development of agricultural expertise across the Nation.

Mr. Chairman, that concludes my remarks. I would be happy to try to respond to questions or comments at this time.

[The prepared statement of Mr. Carter appears at the conclusion of the hearing.]

Mr. Brown. Thank you very much, Dr. Carter. At the present time, does your school have the capability or does it try to track the career activities of your graduates to determine what type of vocation they go into, whether it is related to agriculture or not? I am speaking of your agriculture graduates primarily. Do we have a picture of the kinds of opportunities available to these graduates?

Mr. CARTER. I am not sure of your question. Can we direct the selection of the curriculum that they are choosing?

Mr. BROWN. Do we have a way of following them after graduation to determine the relevance of their occupation to their agricultural training?

Mr. CARTER. We most certainly do. I think most institutions do conduct studies from time to time to determine where their graduates have gone and to give some kind of assessment as to whether what they have learned, what they were exposed to at the university, was effective in meeting their needs. So it is possible to get this kind of information.

Mr. BROWN. I am thinking of this particularly because of the fact that employment in agriculture today is far more diverse than it may have been a few generations ago. It is not strictly onfarm employment. There is a lot of related activities in the overall agricultural industry that can utilize the skills that are obtained in schools such as your own. I do not have in my mind a very clear picture of just what all these opportunities are in California, and at some point I would like to get a little better picture of that.

Mr. CARTER. I would be happy, as I am sure the other deans would be happy also, to provide information on the diversity of jobs that are being taken. Many of the jobs that they are going to now really did not even exist 15 or 20 years ago when we were educated and many of the faculty were educated.

Mr. BROWN. I noticed last year in hearings that we held out in California, there was a whole new class of people who were trained, at least to some level of professional capability, in entomology and were tracking the incidence of pests in agriculture in a fashion I have never seen done before. It is a part of integrated pest management.

Mr. CARTER. This field of plant protection is an area that is becoming extremely important in our State—and I think in other States, too, but especially in California. The Medfly, for instance, is an example of that.

Mr. BROWN. Mr. Penny, do you have any questions?

Mr. PENNY. Just a couple of questions, Mr. Chairman.

Dr. Carter, on page 3 of your testimony, you make reference to the fellowship grants totaling $5 million. Do you have any idea how many fellowships were awarded under that appropriation?

Mr. CARTER. Of course, this is the first year that it will be made available.

Mr. PENNY. I thought it was available in the current school year.

Mr. CARTER. Yes, we have received preliminary indications that proposals will be due very soon, and the decisions will be made, I believe, in August as to who they will go to. I believe it is something of the magnitude of 300 students.

Mr. PENNY. For this coming school year?

Mr. CARTER. They will be selected very soon for the next year, yes. The appropriation came through this last year. It has taken this long.

Mr. PENNY. Do you have any idea what types of programs are going to be emphasized if these fellowships are awarded?

Mr. CARTER. The biotechnology area and human nutrition are examples of areas where expertise shortages have been identified. The focus will be to attract highly qualified people into these areas of shortages.

Mr. PENNY. Later on in page 6, you talk about the grants that are available to various institutions and your strong desire to continue a grant process that allows non-land-grant colleges to get some of the money. How well are you doing now on that?

Mr. CARTER. The strengthening grant concept is in the language of the farm bill now. It has never been provided with funds. Congress has not seen fit to provide funds for strengthening grants, only for the fellowship program. What I was trying to point out here is that the potential for strengthening and the need for this is getting to be more and more important, especially to the non-land-grant schools, the AASCU schools. They do not have the support of the Hatch Act and the Smith Level Act funds.

We also have to keep our faculty current and on the cutting edge of things that are stimulating and make them aware of the new developments in agriculture, and the strengthening grants will provide all of us with this kind of opportunity.

Mr. PENNY. Thank you for those answers, and I also want to commend you for the specific recommendations that you have made in your testimony today. We get a lot of advice, but most of it is quite general. It is nice to have some very pointed recommendations so that we can see precisely what needs to be done to draft legislation to respond to the needs that exist in this area.

Mr. BROWN. Mr. Olin.

Mr. OLIN. Thank you, Mr. Chairman.

Dr. Carter, I have been told that Cal Poly has a rather unique role among AASCU schools and the extension services, and I wonder whether you could elaborate a little more on your extension role and how you interact with the total California extension system?

Mr. CARTER. We do not have a direct connection with the California Cooperative Extension Service. We work very closely with them. Our faculty have joint-authored articles with them, because they do have the expertise that is needed. However, under present legislation, it would take some different interpretations than we have had up to this time to permit us to have funded projects at Cal Poly, even though there is a great deal of interaction. We just sponsored with the local farm advisory—which is called the county agent in many States—a land-use conference.

So we cooperate a lot and work together as much as we can, but there is no connection directly. As it is presently constituted, it is all indirect and strictly based on cooperation and mostly at the local level. There is very little on the State level.

Mr. OLIN. What type of extension services do you have?

Mr. CARTER. In the sense of continuing education, we have a great deal of activity. The example I gave was only one. We work with local farmers, not just in our area but throughout the State on pest control, fruit and vegetable production, livestock production problems, you name it, across the board. Our faculty have been called upon, and they help if they can possibly figure out a way of getting there or working with that individual to provide the service. We encourage that, even though there is no funding mechanism for it, because it keeps them current. We figure that if they are in demand by those people out in the field, they must be teaching the kind of things that we want taught in the classroom. We encourage them to do consulting for that reason so that they are out with the industry that we serve. If they are in demand as a consultant, they are the kind of person that we want in the classroom. If they cannot get consulting jobs, then we may wonder a little bit about whether they really are acceptable to the industry with what they know and the expertise they have. They do not all do consulting, but a very high percentage of our people, either for nothing or for pay, do consult with the public. We consider that as we work on promotion and tenure decisions, whether they are performing a service function or not.

Mr. **Olin**. You comment on the difficulty you are having in getting your staff up to speed on computer techniques and computer technology. Do you feel that you are solving this problem now, or is this going to be a long-term continuing problem?

Mr. **Carter**. I think we are solving it as fast or faster than any of the other institutions. We set up in-service training programs, special classes, for our faculty. We were able to get grants from industry and gifts from people. I don't know if you are acquainted with the Selia Farming Corp. It is a large farming corporation. They found that we needed some computers, so they sent us a check so that we could buy a bank of 16 computers for a lab to teach our faculty and our students. The State of California, like many others, has been somewhat limited in the funding they have been able to give us. We did not feel we could wait for State funding. We went to the public and got our funding to buy the computers we needed. We need a lot more, but we got enough to get started. Every student now has to take at least a beginning course in computer science, and most of them are taking much more. So we are getting there, but we still have a long way to go.

I would say that we still have a number of faculty to get up to speed, you might say, so that they are comfortable and knowledgeable with the use of the computer and start to use it in their classes. Well over half are now actively using it in their classes. They are in some way using it.

Mr. **Olin**. Thank you, Mr. Chairman.

Mr. **Brown**. Thank you, Dr. Carter, for your very helpful testimony.

The next witness is Dr. Henry Wadsworth, representing the Extension Committee on Operations and Policy.

STATEMENT OF HENRY A. WADSWORTH, DIRECTOR, COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, AND CHAIRMAN, EXTENSION COMMITTEE ON OPERATIONS AND POLICY, ACCOMPANIED BY HOWARD DIESSLIN, EXECUTIVE DIRECTOR, ECOP, NASULGC

Mr. **Wadsworth**. Thank you, Mr. Chairman. It is a pleasure to be here and to meet with you and the subcommittee. I have at the table with me Dr. Howard Diesslin, who is the executive director of

ECOP and who has been very much involved in the Computer Electronic documents for ECOP.

With your permission, I would ask that my complete statement be placed in the record.

Mr. **Brown**. Without objection, so ordered.

Mr. **Wadsworth**. What we have been talking about and discussions we have had about extension during the course of these hearings in 1982 and now is the fact that change is constantly occurring, and it is something with which we must all deal. The great ability of the extension service is to help people make informed change—in other words, make decisions where they have a good understanding of what is likely to happen. That occurs because of the ability to apply knowledge to the problem, to disseminate that knowledge widely among the people who will have problems of a like nature, and to command the respect and trust of those individuals that the information they have received is credible.

As the State extension director in Indiana, and as the acting director of the extension service in Oregon for 7 years, and associate director at Cornell, NY, for 3 years prior to that, I have had the opportunity to look at extension services fairly intimately in three States. One of the things that extension in the 1980's has brought forward is that one of the strengths of the extension service system across this country is the Federal-State-local government partnership, coupled with volunteers at the local level, which carries the program down every country road into every small community across this great land.

Second, we find in extension in the 1980's the notion of the great value of the land-grant system, and certainly we subscribe to that and particularly the program flexibility that we now have at the State level to focus our efforts on needs that may be of a particular priority. This does not mean, however, that we do not work on national needs; it simply means that we merge national needs and State needs in order to get the most effective program combination, if that is possible.

Third, in extension in the 1980's, they focus upon the research base, and clearly that is what gives us the ability to gain trust from the people we work with. We do have knowledge that is credible. We do have sources that we can draw on. We do know how that information came about, and we can stand behind it.

One of the small concerns that I have with the extension in the 1980's report is that they did not talk very much about applied research or demonstration-type research. Previous testimony before this committee with our research colleagues has documented the emphasis among those colleagues on doing research, which many might call rather basic. Now, we need that basic research in order to have the information that will be necessary to compete effectively years ahead.

But having that basic information or research results, the question comes up: How do we move from that point to application in the field? We see this as a growing problem, one which resources are going to have to be devoted to, and I think the extension services are in a position to do more if funds are provided for that particular purpose.

Last, I would comment briefly on evaluation and accountability. I would simply say to you that the extension directors around this country share the concern about evaluation and accountability and I think have responded to the need that has been outlined earlier. Administrator Greenwood will probably comment in more detail tomorrow. There are five national studies underway, covering particular programs, and there are in excess of 200 individual State-by-State accountability efforts underway.

In our own State, we are participating in at least two of these national efforts, looking at the effectiveness of the program in our own State, as well as how it couples together with efforts in other States to make the national impact.

I would like to turn now to the question of electronic technology and what is happening. You see in the testimony that was prepared a statement that was prepared by the division of agriculture of the National Association of State Universities and Land Grant Colleges on electronic technology. It is a statement to which the extension services fully subscribe. I think it is very clear to us that if we are going to be as effective as we ought to be, we have to utilize all the available technologies to their greatest abilities.

We work with people, and we know that many times they are asked to incorporate technology into their own business and in what they do. We expect them to look at these technologies and use those that are useful to them and help them get the job done most effectively. I think we can ask no less of ourselves to apply that same kind of analysis to these current technologies. We believe that by applying what is available, we will increase our ability to serve our many clientele. We think we will not only increase the numbers of clientele we will serve, but we will increase the accuracy of the information and analysis that is provided to them, and we will increase the currentness of the information that they have available.

The use of electronic technology will also help us translate research into a more usable form. We need to take it from the results that come from the bench of the laboratory and put it in a form which the user can take to his particular business or enterprise and apply that to the circumstances that he has. In many ways, this comes under the form of software development that incorporates elements of the research into a systems type of information analysis.

We frankly believe that we may be on the verge of entering a major era in agriculture in this country, and that is one in which management becomes the crucial element in the profitability and the survival of agriculture. You will find a table at the end of the testimony in which we chart major periods in American agriculture. We pose that as a question because we see the possibility that computers may well be the most important management tool for American agriculture in the remainder of this century.

There are now computer networks. What I mean by computer network in this sense is a network for every county office in the State that is connected with the State office of that extension service in about one-quarter of the States. Other States are working on developing this kind of capability, and there are also some regional cooperative arrangements whereby, through computers, information is shared between States.

Hardware has become a problem for most of the States in moving in the direction of computers. Industry has changed rapidly in the kind of equipment that is available and the capabilities of that equipment. Most extension services have not had a substantial amount of money needed to make frequent changes in the kind of hardware they have. Therefore, when they made that decision, they wanted to make it the best that they could for the long run. Some have procrastinated because they were concerned about the fact that the equipment might be out of date by the time they could get it installed.

Some hardware has also come a long way, and one of the things that recent development in the hardware industry has brought to us is the ability of various kinds of hardware to use different kinds of operating systems. This means that the opportunity to share between States and between agencies is now more likely to occur in the years ahead, simply because of the kind of developments that have come in the private sector.

Last, I would turn to a question on the issue that you brought up in your opening statement, and that is the Smith Lever formula. As you noted, the base formula for Smith Lever 3(b) and 3(c) was established in 1962 and has been basically unchanged since that time. There have been some 3(d) items that have been added in the period since 1962 with their own particular formulas.

Following the 1982 testimony before this committee, ECOP did appoint a task force to look at the formula funding situation. We asked the task force to review what had happened in the past, look at things as they saw them in the future, try to be responsive to inputs that they were getting from a variety of sources at that time, and come back to ECOP with recommendations that they thought were appropriate. The task force then met in late 1982 and 1983, and they came back to ECOP in early 1983 indicating that any change in the formula ought to grandfather the current 3(b) and 3(c) funds at their current levels in order to minimize disruption of programs; that the current 4 percent ought to be retained for Federal administration, and that 20 percent ought to also be retained to be equally distributed among all States. They also suggested that the guidelines would include appropriately recognizing total population, and agriculture as broadly defined.

These guidelines were accepted by ECOP, and the task force continued to deliberate. In August 1983, they presented their final recommendations to ECOP. Those recommendations indicated that the existing 3(c) funds, excluding retirement and penalty mail, should be shifted to 3(b) and such funds allocated to the States henceforth at the level of formula funds received in 1985; that the Smith Lever Act should be amended to expand the 3(b) section to allow the Congress at which time they may choose to shift 3(d) funds to 3(b), with the allocation then of each State henceforth equal to that received for the rest of the year.

With respect to future increases in Smith Lever 3(c) funds after 1985, that task force recommended that 4 percent of this go to Extension Service USDA for administration and that the remainder be divided, 5 percent to States or groups of States for special projects, 20 percent equally among all States, and 15 percent among the States on the basis of cash farm receipts, 25 percent according to farm population, 25 percent according to rural population, and 10 percent according to total population. They also made some recommendations with respect to how they thought these databases could be developed and how they should be put in process and how often they should change.

Well, as you can well understand, this discussion of formula funds is one which involves everyone's interest, and they wanted to look at it. So, following this presentation in mid-1983, we took it to a discussion of all extension directors and extension administrators at the 1983 annual meeting of the extension section of the division of agriculture. The meeting was so involved and the discussion so intense that it was not possible for us to reach a decision at that particular time. So a full meeting of all extension directors and extension administrators was convened in February of this year to discuss this issue again.

I had asked, in the intervening time, that the regional chairman of each of the four directors' groups work with the directors in their regions to examine this recommendation and come back to the meeting with an expression of the consensus position of their respective groups. This they did at the February meeting, and their reports indicated that the extension directors across this country were about equally divided in their support of the existing formula vis-a-vis the recommended modification. They did support the transfer of 3(d) funds to 3(b) as innovative programs mature.

As a result of this, the consensus of ECOP was that there was not sufficient reason for us to press for a change in the formula at this time and in the 1985 farm bill. I think that if such a change is going to occur, then we need to have a clearer indication for all States if there is a change in legislative intent, and that there is a strong sentiment by Congress and the executive branch that such a change is in order. Given that, I believe that extension directors can work together to develop a formula revision that would reflect such guidelines.

Mr. Chairman, it has been my pleasure to be here today. I have appreciated, on behalf of my colleagues, the manner in which these hearings have been conducted since 1982. And if there is any further way in which I can be helpful, I will be glad to do so.

[The prepared Statement of Mr. Wadsworth appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you very much, Dr. Wadsworth.

This question about the possibility of a formula change is one which tests the statesmanship of every extension director. It would be highly unusual if extension directors could look at the formula without considering what the impact would be on the distribution of funds in their own State. I suspect Congress can look at it the same way. Can we get beyond that—I will not say "above" or "below" it—to consider the fundamental equities involved here? What should be the driving force with regard to consideration of a formula change in your opinion?

Mr. **Wadsworth**. In my opinion, the driving force should be the congressional intent for carrying out the responsibilities as provided in the legislation.

Mr. BROWN. By that, do you mean the congressional intent with regard to what they want extension to do?

Mr. WADSWORTH. That is correct.

Mr. BROWN. That seems very reasonable.

Mr. WADSWORTH. As I read the discussion that occurred over the last 6 months, it seemed to me that what was being asked was, if Congress accepts the extension in the 1980's report as it was published and distributed, does the new formula any better represent the intent, in terms of service to the people of this country, than the existing formula? That was the dialogue that was occurring.

Mr. BROWN. As you are well aware, Congress, in enacting some of the 3(d) programs, EFNEP and urban gardening for example, was expressing a view, for whatever reason, that a certain amount of extension resources ought to be devoted for certain types of urban programs. I think you would agree that it would be better if the Congress did not have to resort to the kind of earmarking embodied in the 3(d) program and left it to the partners to develop their own priorities within general guidelines. But if those general guidelines do include service to an urban population, then the formula probably ought to include some consideration of urban population weight, as the proposed formula did here. The question of how much is enough is something very difficult to work out, of course.

Mr. WADSWORTH. I suspect that is reasonable. As you know, there is nothing in the way the funds are distributed now that would prevent an extension director in that State from allocating funds for those programs that needed to be done in urban areas. He has that flexibility now.

Mr. BROWN. That is correct. But extension directors, very justifiably, look for some clues or cues as to what would be the most appropriate way to distribute the funds. I am personally convinced that extension, with the limited funds available to it, cannot undertake large-scale urban programs unless they do so through the medium of modern technologies such as telecommunications or something of that sort. They cannot do the kind of one-on-one programming that we are accustomed to thinking of as the strength of extension in connection with the farm population.

Mr. WADSWORTH. I would agree with that statement. I think we tend in our State to look at it that we have programs that are proactive and others that are reactive. By a "proactive" program, I mean that we have a definite target clientele group whom we think will particularly benefit from that information, and we undertake very distinct efforts to accomplish that. By "reactive" I mean we have information that people can use and they would find helpful if they had it, and we provide that mainly through media kinds of events.

Mr. BROWN. I personally appreciate the work that ECOP did in connection with studying this issue, and it will be essential input to our deliberations in connection with next year's revisions of the bill.

Mr. Penny.

Mr. PENNY. Mr. Chairman, I do not have any questions, but I do want to thank Mr. Wadsworth for his testimony.

Mr. BROWN. Mr. Volkmer.

Mr. Volkmer. I pass.

Mr. Brown. Mr. Olin.

Mr. Olin. Just a couple of questions, Dr. Wadsworth. You mentioned that you have in Indiana a complete network of computer communications between, I take it, Purdue and the agents throughout the State?

Mr. Wadsworth. That is correct.

Mr. Olin. How far along are you in developing software packages that individual farmers can use directly?

Mr. Wadsworth. In terms of individual farmers using software packages, they cannot do it on equipment that they might possess on their own farm through a telephone modem to our computer facilities. They can come to the county extension office and work with that staff to have a particular kind of program analysis, using whatever software they would select that we would have available, and get analysis done in that manner, or they can come to the main campus and do the same.

Mr. Olin. Are you doing any work on standardization and compatibility, such that you are looking forward to the time when you could specify some range of hardware which farmers could buy which could be software-compatible? The choices of this type, of course, are increasing every day.

Mr. Wadsworth. This is a problem we have all faced. We have decided to take upon ourselves right now this challenge when we make the next change in hardware. As the first State to have this complete network in 1978, we had the same equipment throughout the system and the same operating system. We are now going to provide flexibility to our counties and our staff, and we have prescribed the operating capabilities of the equipment they ought to have but not the make of that equipment. We have also specified some range of operating systems. This gives us a matrix, and we are going to try to make that matrix function, letting each county tie in. It may be a county computer, it may be one they have themselves, it may be that they have better service for that in their own locale than somewhere else, and we are going to try to hook all those different elements together and make it work. But we are just at the beginning stage of that.

Mr. Olin. What about the cooperation in this respect with other States that have a similar agricultural application? Does the vehicle exist to work on standardization and compatibility on a broader front?

Mr. Wadsworth. Yes. Mr. Diesslin, the executive director of ECOP, may want to comment on this. We have in the north central region what is known as the North Central Computer Institute, and that is one of the major purposes of that institute to in fact accomplish just what you have described.

Mr. Olin. You would, I take it, look forward then to the point where you might arrive at a better capability of doing some software development more centrally—regionally or even nationally?

Mr. Wadsworth. I would look at that, as well as the full utilization of software that is developed in the private sector.

Mr. Olin. Does Dr. Diesslin have something to add?

Mr. Diesslin. Just a brief analogy. Until we got the three-point hitch in farm machinery, you know how much incompatibility there was from one equipment manufacturer to another. We are still looking for the three-point hitch in software. Now, more and more, as individual companies become dominant—obviously, "Big Blue" is one we all think about—and other companies come on and say, "Our software is compatible with IBM's," you begin to move toward the so-called "three point hitch" in software, in terms of operating systems.

Now, obviously, we have probably a half a dozen yet that are still out there competing, but more and more we are beginning to see this narrowed down.

Mr. Olin. Thank you very much.

Mr. Brown. Mr. Volkmer.

Mr. Volkmer. I would like to continue with that. What information is available through the computer network that you have in Indiana?

Mr. Wadsworth. I do not have a complete listing with me. We have information in there with respect to fertilization, integrated pest management, and appropriate kinds of pesticides to use in a particular situation.

Mr. Volkmer. As a generality, are they data that have come from your experiment stations and from your research facilities?

Mr. Wadsworth. That is correct. We have built on the work of our research colleagues and have put it into a form that we could use it with the people who would be interested.

Mr. Diesslin. They have at least 60 software programs that are specific to agriculture conditions in Indiana that will answer specific types of management problems, all the way from fertilization to what you can pay for an additional 80 on your present farm.

Mr. Volkmer. What if I wanted to know what research you have done as far as corn and different hybrids, if any?

Mr. Diesslin. No, I doubt if we can help you much on that. We don't carry the library-type information at this point.

Mr. Volkmer. Thank you very much.

Mr. Brown. The word "library" ticks me off a little bit. When are we going to be able to connect all these computers to the National Agricultural Library and have a truly integrated system here?

Mr. Diesslin. Congressman Brown, I think we are beginning to see the signs of some daylight there. If you have watched the appropriations to the National Agricultural Library in recent years and the emphasis that USDA Science and Education is giving to this element, I think it is a very bright spot. I think we have the kind of leadership in the National Agricultural Library now that is looking precisely in that direction. Obviously, it is going to take some time.

Mr. Brown. Yes, I have been pleased with that, too. The augmentation of the budget has not been all that overwhelming, but it has been a comfortable growth so that it did encompass some opportunity to do some of these things.

Mr. Diesslin. It is a lot more comfortable than extension has been in the last 2 or 3 years.

Mr. Brown. That is true. What technology are you using for your software packages? Is there a uniform type of method that is being used?

Mr. Diesslin. I guess I would have to answer at this point that every State is kind of going in their own direction. You know, scientists have a tendency to be individuals, and the States are getting some compatibility among their scientists at their particular institution, but we have a long way to go yet to get Iowa and Purdue to be fully cooperative. I think the institutes at Madison and the institute now at Penn State for the Northeast, and we hope the two that are coming onboard or may come onboard in the South and the West will give some impetus to this over the next 3 to 5 years. We have a long way to go in that direction yet, as have the multitude of companies that are selling software out here on the road.

There does exist today the opportunity, however, if a piece of software is written for particularly one operating system, to get another software package that will take that and translate that into another form. As these work better and more efficiently, our ease of bridging these gaps is going to be much better than it has been in the past.

Mr. Brown. Thank you very much, gentlemen, for your help. We appreciate that.

Next I would like to call two witnesses to serve as a panel: Mr. Bruno Leps, general manager of Grassroots Videotex System for the Eastern United States, and Dr. Ralph Adkins, who is special assistant to the director, Cooperative Extension, University of Maryland. They will help us understand some of these systems a little bit better. Do you want to start, Mr. Leps?

STATEMENT OF BRUNO LEPS, GENERAL MANAGER, GRASSROOTS AMERICA, ACCOMPANIED BY JOSEPH D. COFFEY, DIRECTOR, ECONOMICS AND PLANNING, SOUTHERN STATES COOPERATIVE, INC.

Mr. Leps. Thank you, Mr. Chairman. I have with me here today Dr. Joe Coffey from Southern States Cooperative. If you will, I will just give an overview of what our program is doing to indicate who we are.

Mr. Brown. Please do that. That will be very helpful to us. Any prepared material that you have can be included in the record at this point, of course, and you handle it in the way that you think will be most helpful to this subcommittee. We have your package.

Mr. Leps. Thank you. Just as background, Grassroots America is a joint venture of three cooperatives, Agway, Cenex, and Southern States, and Videotex America. Videotex America is, in turn, a partnership between the Times Mirror Corp. out of California and Infomart.

Mr. Brown. Is this the system that we saw demonstrated down at the Chamber of Commerce a few weeks ago?

Mr. Leps. Yes, it is, sir.

Mr. Brown. Fine. Go right ahead.

Mr. Leps. Informart is, in turn, a videotex service company based in Canada that started the Grassroots some 2½ years ago.

The service that is being launched here in the United States is an agricultural videotex service. Maybe I should just define videotex for you. What we are looking at is a service that allows a user to access a databank of information services through the telephone network. Grassroots is specifically geared to the agricultural community. In the launching of this service, it was our feeling that today the farmer, as he becomes more and more of an entrepreneur and a businessman, needs more up-to-date information, needs more tools at his disposal, more timely information to be able to run his business.

At the same time, we look at what we call the information-provider community, the people who want to communicate with that farmer, needing more cost-effective tools and means whereby they can communicate their information. As such, at Grassroots, we are launching in the United State today a service that is going to cost the subscriber $50 per month, including 2 hours of usage, and it will be $9 per hour thereafter.

In the launching of our service, we have to take great care in making sure that the information is localized to meet that farmer's information requirements. As such, Grassroots America, even though we are launching a national service, we are initially going to be concentrating in the States of Maryland, Delaware, Pennsylvania, parts of New Jersey, and Virginia.

In developing this type of service to meet the information needs of the farmer, we have been working very closely with extension people. We look to them as a source of a lot of the information that can meet the needs of that farmer. As such, we have formed an agricultural database advisory council, which is comprised of extension people, university people, agribusiness, and farmers. This group provides input and provides direction as to where we should go in getting information that is required to meet the needs of the farmer.

To date, Grassroots America does not have any subscribers. We are planning to roll out in July, and we are still looking on target for that. But if I may just take a couple of minutes to relate back to the Grassroots service in Canada, it has a 2½ year track record. We currently have some 2,000 subscribers. We have very close cooperation with universities and extension people up there, and a recent survey shows that in fact 80 percent of the farm community of our subscribers felt that to be a very cost-effective tool.

[The prepared statement of Mr. Leps appears at the conclusion of the hearing.]

Mr. Brown. Did you say 2,000 subscribers in Canada?

Mr. Leps. Yes, that is correct.

Mr. Brown. Do you have an estimate of what your market penetration is there or how much this represents?

Mr. Leps. In Canada, we are looking at 10,000 to 15,000 farmers. In the United States, we are looking over the next 10 years or so in the neighborhood of 200,000 to 300,000 farmers.

However, if I might just elaborate on that a second, I think there is also a possibility here, even though individual farmers may not have it in their home, accessible directly, in Canada a lot of the extension services have this service right in their offices and as such provide accessibility to these services to a much more general base of farmers.

Mr. Brown. I suppose that where farmers could get together and jointly make use of the service, they could beat you out of a lot of individual subscriptions, could they not?

Mr. Leps. That is a possibility; correct.

Mr. Brown. If they all had access to an extension service office, which was convenient for a few hundred of them and they wanted to do that, they could get the benefit of the service with a minimum amount of outlay?

Mr. Leps. That is correct, Mr. Chairman. I would answer that by saying that the onus is on us to be able to provide enough personalized types of services where the individual subscriber will want to have his own ID and password to get on the service.

Mr. Brown. Dr. Adkins, I want to hear from all of you before we ask questions. You may proceed.

STATEMENT OF RALPH J. ADKINS, AGRICULTURAL PROGRAM SPECIALIST AND SPECIAL ASSISTANT TO THE DIRECTOR, MARYLAND COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MARYLAND

Mr. Adkins. Chairman Brown, you have a statement on the Estel System. We would like you to incorporate that into the record, and I will just highlight parts of it briefly.

Mr. Brown. We have this brochure, and we have a statement by you, yes. Those will be incorporated into the record.

Mr. Adkins. Thank you. Let me just briefly go through part of those. The Estel system started back in 1982 on a trial basis, where we were attempting to develop an information-delivery system based on the computer technology. We have been very concerned with problem-solving and office management and many other computer applications, but we felt there was a real need for information delivery. This looked like a good way to do it.

We are operating on the Eastern Shore of Maryland. We are covering the entire Eastern Shore at this time. We have two county host units: one on the lower-shore and one on the mid-shore area, serviced by a State unit at College Park. The unit at the college collects information from USDA, from the National Weather Service, and from our extension specialists, packages this all together and downloads it daily to the county extension offices.

The users in the county can access the computer equipment at the county extension office on simple videotex terminals. In fact, that is what we started with. Now, many of them are using microcomputers of all kinds. We started primarily providing information on futures prices. Chicago Board of Trade prices was what our farmers had the greatest interest in. At this stage of the game, they are interested in fresh market vegetables and livestock markets. We are heavily involved in weather information and in integrated pest management reports. As we proceed down the road, we see the county extension offices having an opportunity to input information into the system, which will localize it and make it much more immediately beneficial to the county farmers.

We find that the users of the Estel System are not people who want to peruse a great variety of information but primarily have single sources of need that they are signing on for. Once you satisfy this need, they may look at other information, but generally we have target groups that are looking at specific information.

The wives of our farmers were not one of the target groups that we started with, but we found quickly that as their husbands started to use this system, they started to ask for home economics information from the extension service. We found 4H information fitting into the system. We use it for a calendar of events and these kinds of things, to keep farmers up to date on what is happening.

When we talk about the cost of the system, the State host unit that we have at College Park, we have invested about $10,000 into this system. The county host unit costs about $14,000. I guess this is probably as good an example of public and private cooperation as we have. Almost all of the funds in this come from the farm credit banks, the local farm bureau groups, to finance this operation and put it together. The major decisions made in the county of financing and operating the system are made by county advisory groups, groups of farmers that decide what information they would like to see on it and how they would like to finance it.

The cost of the system to the grower is $40 per year, and the system is available 24 hours a day, 7 days a week.

Some of the interesting things that we found about our Estel users that you might find interesting, they range in size of farms from 50 acres to 2,000 acres. We are finding that they average about 450 acres. Most are grain farms but some are in combination with vegetables and broilers. About half of them are accessing the system with videotex terminals and nearly half with microcomputers.

We find that the most popular time for using this system is from 4 to 6 in the evening, and that is about the time that the settlement price from the Chicago Board of Trade comes in. The next most popular time is from 12 to 1. The length of time that they stay on system runs from about 1 minute to 30 minutes, averaging about 6 minutes. About one-third of them use the system once a day, about one-third use it more than once a day, and about one-third use it three times a week. About 77 percent of them operate the system themselves, with the remainder depending on their wives, employees, or other family members.

Marketing information is by far the most popular information that we use. The weather is the second most popular. The Ag AM news that is prepared by USDA is the third choice. Pest management is probably the fourth most useful information. The biggest thing I guess that our users tell us is that they like the convenience of this type of information; it is there all the time.

As we look at any type of electronic information system, whether it is Estel or Grassroots or anything else, the first consideration is the reliability of the hardware. I think in extension in the last 2 years, we have worked to put together a system of hardware and software that we think is reliable, and it seems to be working well now, serving about one-third of the State of Maryland.

The next crucial part of it is the development of a database. During this coming year, we plan to put microcomputers in all our county offices that have the capability of feeding into this system. We are also putting microcomputers into each of our academic departments that serve extension to that they have the opportunity for their specialists to feed directly into the system.

We depend heavily on the Ag Marketing Service for our Chicago Board of Trade prices and our vegetable market prices. The National Weather Service has been a tremendous asset to us in providing up-to-date county-by-county weather forecasts and specialized agriculture forecasts. A cooperative project with them is providing marine weather forecasts. We provide weather forecasts updated three times a day, giving offshore and high-sea weather forecasts from Key West to Newfoundland. This is not a product that is of particular interest to our farmers, but it is of interest to marine weather users who work with the weather service.

It is interesting, looking at this system here today with the Grassroots people, Southern States and Agway have been one of the long-time traditional cooperators with the extension service. We have a long history of working together. I think as you look at public-private relationships, Agway and Southern States have kept the Maryland Extension Service informed right to the minute of what they are doing and what their goals are and where they are trying to go. We have extension specialists in Maryland, in Delaware, and in Pennsylvania who are serving on their advisory boards. We have Estel Systems set up in Agway stores, available for farmers to come in and use at their will. Each day, Southern States provides us cash grain prices from Baltimore and CFER, Delaware, to go on the Estel System. So the cooperation between the two organizations has been good and we look forward to its staying that way.

[The prepared statement of Mr. Adkins appears at the conclusion of the hearing.]

Mr. Brown. Thank you very much, Dr. Adkins.

Do you have a statement, Dr. Coffey?

Mr. Coffey. No, I do not.

Mr. Brown. Do you have any questions, Mr. Roberts?

Mr. Roberts. I have a question for Dr. Adkins. It seems to me, with 41 subscribers, you are not growing by leaps and bounds. Do you anticipate any kind of major clientele starting to subscribe? Why has the growth been so slow?

Mr. Adkins. The growth has been slow, and it has been slower than we anticipated. I think the growth has been limited by the hardware that we had available to devote to the project. I think as we move forward, we will see the growth improve, but I am not looking forward to an overwhelming number of people on this system for a while. I think it will be a slow, measured kind of growth. I think we will be able to build a clientele that will stay there and use the system. But I do not really see it as a tremendous flush of people coming into the system. I think it is the kind of system that will grow with the same speed that our farmers adopt computers. I think as they buy computers, this will be one of the services that they will want with their computers.

Mr. Roberts. In other words, it is the hardware—the lack of availability of that—or the farmer going into the computer information business, as opposed to the information——

Mr. Adkins. Probably some of both. Our initial limitation, we think, has been the hardware. This coming year, we are concentrating on developing a wider and more indepth information system. We are planning to put one of the host units on the College Park campus to serve Prince Georges and Montgomery Counties. We think when this happens, we will develop a larger user group in home horticulture areas. We will see more recreational boaters and this type of user on it than we have now.

Mr. **Roberts**. What do you think would be the difference between the clientele serviced by Grassroots and by Estel? Is it more localized with Estel?

Mr. **Adkins**. I would say this would be the major thrust of the Estel unit, a more localized system than Grassroots perhaps would provide. Estel would not have the global kind of material that Grassroots could provide. I would see as information starts to flow in from county extension offices, the information would be very local. I guess I would see that is where we would dovetail with Grassroots, on the local part of the thing.

Mr. **Roberts**. I have no more questions.

Mr. **Brown**. Dr. Adkins, what is the comparative size of your database with the Grassroots database?

Mr. **Adkins**. I cannot speak for the Grassroots in America, but in Canada there probably would be very little comparison with the size of the database. Theirs would be much larger than ours.

Mr. **Brown**. It is my recollection that you said you had something like 80,000 pages of data or some huge figure?

Mr. **Leps**. The total databank available is closer to 120,000 pages. Now, that includes material that we consider to be part of lifestyle. The agricultural information base is currently 45,000 pages.

Mr. **Brown**. Mr. Volkmer.

Mr. **Volkmer**. I would just like to ask Dr. Adkins if he foresees, following on the question of the gentleman from Kansas, any increased growth in the users of the Estel system?

Mr. **Adkins**. Yes, we do see an increase, and we see it spreading across the State. We consider the installation of computers in our county offices as the first step to moving this across the State. We started on the Eastern Shore. We have covered the shore. We probably will be working on the Western Shore this coming year. We see it continuing to grow.

Mr. **Volkmer**. You would cover the State in about 3 years then or 4 years?

Mr. **Adkins**. I would say in the next 2 years we should have unit capabilities in each county.

Mr. **Volkmer**. All the way up to Cumberland and in that area?

Mr. **Adkins**. Yes. In fact, those counties are the counties that probably could make better use of this kind of technology than many of the urban counties because of the distance from the college. This will allow access to specialists and educational programs much more. We have dealt so far with this in terms of an information delivery system, but I think the thing that extension has to be aware of is that this is an educational tool, a way to deliver information that can be adapted to existing programs and used as an educational tool, more than just an information delivery system.

Mr. **Volkmer**. To get to the educational tool, will you not have to increase the capability of your hardware?

Mr. Adkins. Not very much. We are not nearly at the limit of the hardware now. We probably have been limited as much as anything by the ease of putting information into the system. It has been difficult for specialists to feed into a system that they do not have ready access to, and we are hoping that this will improve this year. The specialist can develop the results of his variety plots, sit down at his computer in his office or have his secretary put that into the system and make it available across the State.

Mr. Volkmer. Do you see your system as competing with Mr. Leps?

Mr. Adkins. In the beginning we did, and we were very concerned about that. As the system has developed, as theirs has come closer to coming on line, and as we stayed in contact with them and saw what they were doing, no. We see some overlap in some areas, but basically I do not believe they will be in competition with each other.

Mr. Volkmer. Will I, in the future, be able to use the same software to access both systems?

Mr. Adkins. I think you can right now.

Mr. Coffey. I would like to comment on that, if I might. My name is Joe Coffey, and I work for Southern States. I used to work in the universities. I see both universities and the private sector having opportunities in this area and, in some areas, working jointly. I think the farmer in the future will maybe subscribe to multiple computer services, as he now subscribes to multiple magazines. He may get the Farm Journal for one thing, he may get The Wall Street Journal for another, he may receive the Maryland Agricultural Extension newsletter for a third type of service. So that is the way I would see it.

Each one of these services will have certain unique attributes, if you will, which the farmer may see. The same computer can in fact subscribe or access these multiple systems.

Mr. Volkmer. He would just have to pay his user fee; is that it?

Mr. Coffey. That is correct, just as you would when you subscribe to others. Certainly the Wall Street Journal costs more than other types of publications, but there will be different prices on these and different reasons for using these different services.

The other point that I would add to it is that many of these services—and at Grassroots, we anticipate this, that we will get into actually electronic ordering, electronic banking, or at least opening the door for these kinds of vehicles. So there will be more than just simply providing information to farmers. It is our anticipation in the future that farmers will actually be buying and selling products via their computers. So it will be more than just simply a newspaper, if you will; it will actually be an exchange for shopping.

Mr. Volkmer. The Grassroots program, what geographical areas do you presently cover?

Mr. Leps. In Canada, Grassroots covers from Quebec to British Columbia. In the United States, Grassroots America is being launched in Maryland, Pennsylvania, Delaware, New Jersey, and Virginia, but the intent of that partnership is to launch across the United States, except for California, where there is another partnership called "Grassroots California"—very imaginative names—to launch the service in early 1985 across the State of California.

Mr. VOLKMER. You are starting East and you will move West and South?

Mr. LEPS. That is correct. It is our estimation that we would be rolling out of our phase I area somewhere in the second quarter of 1985.

Mr. VOLKMER. Thank you, Mr. Chairman.

Mr. BROWN. Mr. Gunderson.

Mr. GUNDERSON. My question really follows up on something Mr. Volkmer asked in terms of duplication. I am a little interested in why someone would want both services. It seems to me that eventually when both were fully developed, it is sort of an either-or situation.

Mr. LEPS. I do think you will find that as we develop, there are going to be emphases that will differentiate these types of services. You cannot be all things to all people, and certainly in the electronic media this is very true. For instance, in a service like Grassroots, we may end up specializing in certain large broad market segments within the farm community, such as grain farmers, such as livestock producers or whatever. We believe there will be a lot of room for services to specialize and provide even more localized information to address very local types of needs in these types of services.

We do see a complementary role, and certainly from our standpoint, from the Grassroots America standpoint, we are electronic distributors of information and information services. We do not in fact develop these services. We are not creating agricultural expertise. We are very much depending on extension research, extension feedback, and their contact with the farm community to give us leadership, to give us an exchange of information to be able to know what to do, how to better meet the information needs of the subscriber we are trying to serve. This is really where we see the cooperative type of service.

For instance, on the Grassroots type of service, you have a broad range of available services. There are what you call "closed user groups," which are small segments of the database that you can subscribe to that meet specific information needs. If I can give you just a brief example, when you subscribe to Grassroots, you have access to the major commodity exchanges. However, those commodity exchanges currently are on a 15-minute delay. The broker wants those commodities on up to the minute; you can subscribe to that up-to-the-minute information. You do have the specific interests, if you want, within that market that we see the various services targeting on and living jointly together.

Mr. VOLKMER. Will the gentleman yield on that?

Mr. GUNDERSON. Why not let Dr. Adkins comment, and then I will yield.

Mr. ADKINS. For years, we have provided information to the Southern States Cooperator magazine. This has been a very fruitful way for us to get our extension information out to farmers, and I am sure we will provide some information into their system, just as we will depend on them for their Southern States marketing information in our area. These are some of the ways that we will work together. Many of our users probably will be smaller users than what are on Grassroots. We will put a lot more local information in. One of the examples that comes to mind is the integrated pest management service, where we have scouts in the field reporting back in to the university, with entomologists making up a weekly scouting report. This is going directly into the Estel system right now and is fed directly back to the farmers.

Mr. **Volkmer**. I would just like to ask you a little hypothetical. You mentioned the board of trade information, but soon it will be time to harvest wheat. In some places, I guess they already are. Usually in our area it is definitely a cash crop; nobody can store it very well. So what you do is, the farmer gets on the phone and starts calling around the elevators to see what the prices are. Eventually, will that information be available, and how would you obtain that information from the various elevators in order for them to use it?

Mr. **Leps**. In the development of this electronic publishing industry, there are a lot of side businesses that are evolving. Yes, we are addressing the local elevator price. The way we address that is that there are small entrepreneurial types of organizations today that are looking for outlets and new avenues for publishing that type of information. So in fact, in Grassroots America, we are subcontracting to a company that is going to hire staff, that has staff now, that is going to call around those local elevator prices so that it will be available to the subscribers.

Mr. **Volkmer**. Would the same thing be true for livestock markets then?

Mr. **Leps**. Yes.

Mr. **Adkins**. We are using our livestock markets primarily from USDA, from the Ag Marketing Service. They have market reporters at about five livestock markets that serve Maryland, and this information is fed in on the day of the sale. The grain marketing prices, the cash grain prices, we have a secretary in the local extension office who calls four or five grain elevators in that county each morning and gets the daily prices.

Mr. **Volkmer**. And that comes back in to your computers?

Mr. **Adkins**. Yes.

Mr. **Gunderson**. Mr. Chairman, I do not have any further questions, but I will be most interested in 5 years to see where all this develops. I think one or two things will happen. Either you are both going to be in direct competition—public sector versus private sector—or else the public sector role is going to become a very specialized role, frankly, dealing with information that is nonprofitable to the private sector. It seems to me that we have one of those two alternatives facing us in the future.

Mr. **Brown**. Just following up on that, there is a large class of nonprofitable information which we call "basic research." [Laughter.] I think that the public sector is going to continue to have a very strong concern for that.

I want to explain one additional area here, and this has to do with the fundamental role of extension. Dr. Adkins, you referred to the fact that you expect some growth in the large home horticultural users group. I happen to live in northern Virginia, which has a very good extension service and a lot of home horticulturalists. I occasionally use that extension system over there. I will give you two or three examples.

When it looks like we're about to be hit with Japanese beetles or gypsy moths, we need some quick information from extension about what is the best thing to do. So we call up the extension service and after waiting on the line for quite some time, we frequently get somebody who can give us the right information. As another example, I had occasion to wonder why I could not get blooms on my wisterias, so I called up to try and find out what was the best way to handle wisteria culture.

I am wondering if there is not a role for extension in doing a more effective job of packaging this kind of information for urban horticulturalists on some sort of videotape or some scheme where we could dial it up, access "Japanese beetle" for example, and find out what is the current status of the Japanese beetle infestation and the proper remedial action to take. Urban horticulturalists would probably benefit from that sort of thing, and it would not require the use of expensive manpower waiting at the other end of a phone in order to do that.

We have something similar in the health field called Telmed, which is a telephone system where you can find out what to do if you think your kid has measles or something like that.

Mr. ADKINS. Very definitely. There are a number of States that are using home horticulture systems similar to that, with a bank of telephone-taped messages. You call in and request the message that you want and it will answer those questions. We think the Estel system will help to do that similar thing in an urban population where you have a lot of home computers. In our particular area, we have a very high proportion of people with personal computers at home.

We think this will assist with that. It will not answer the question, because in the spring or when the Japanese beetles first hit, we are overwhelmed with those kinds of calls. I do not think Estel or anything else will keep you off that telephone entirely. You will probably still have to wait a while, but it will help. It will be another way of getting that information out.

We think we can build up a bank of information, very current and timely. When the Japanese beetles are about to come, we will put that information in. When it is over, we will take it out and replace it with something else.

Mr. BROWN. By extrapolation, you might think of something similar to that for the whole range of information that you might call nutrition information, the sort of thing that we are getting out through the EFNEP Program. So not only poor people on welfare who have the benefit of an EFNEP staff member could have that kind of service but anyone who had particular questions about nutrition or domestic management problems of various kinds could access that information and have it available. We could package it and distribute it in a much more cost-effective way and to a wider audience than we are doing now. Is that possibly in the cards through the further development of the kind of systems we are talking about now?

Mr. ADKINS. Absolutely. That is exactly the kind of information that we think is very possible and has very much potential to distribute this way. We are using best food buys and those kinds of things right now.

Mr. Brown. I am trying to draw some lines here, where extension can utilize its expertise, its knowledge, its software packaging capability to do this but not get into the trap of trying to provide this kind of direct one-on-one communication with every person in the urban population, which I think gets beyond the realm of extension and is ultimately going to take away from your higher priority activities.

You have helped our understanding a great deal, gentlemen. Thank you very much.

Our next witness this afternoon is Dr. Ted Hullar, who is director of the Experiment Station at Cornell. We will shift our perspective here to encompass research policy and research priority-setting.

Dr. Hullar, we have your statement. It will be included in full in the record, and you may present it in such way as you see fit.

STATEMENT OF THEODORE L. HULLAR, DIRECTOR, AGRICULTURAL EXPERIMENT STATION, AND DIRECTOR FOR RESEARCH, COLLEGE OF AGRICULTURE AND LIFE SCIENCES, CORNELL UNIVERSITY

Mr. Hullar. Thank you very much, Congressman Brown. I am very pleased to be here, and that you were able to fit me into today's schedule because I could not be here earlier last week. I am particularly pleased because we do have three things that we do in agriculture: we do extension, we do instruction, which are the features today; and we also do research. I think it might be appropriate that there is at least one person here today speaking about research.

What I would like to do is discuss two or three things and summarize these, which are in my statement. The first is to examine the kind of research programs that would be necessary for emphasis and, second, the ways of funding those as we look to the year 2000, but as a prelude to that, to discuss the role of universities in all of that. In presenting those three major ideas, I would like to focus very briefly on five major themes.

First of all, I would make the assertion that universities are the central part—not just one part—of our national agricultural research system. Second, basic research is in fact at the core of our universities and ought to be recognized as such and nourished as such. Third, competitive grant programs are essential for basic research in agriculture. Fourth, our competitive grant programs for basic research in agriculture must have certain characteristics. And last, I would like to suggest a series of recommendations that more competitive grant programs are needed for effective basic research and graduate training in agriculture.

There are two points I would like to make about universities. The first is to recognize that universities do deal with all three parts. They deal with research, teaching, and extension. Certainly the most unique element of that threesome, however, is that universities are solely responsible for the training and education of our graduate students who then become the research scientists in our governmental and industrial laboratories and who also become the faculty in our universities. That is a responsibility held by no other partner in our national agricultural research system, and therefore I would assert that this places special responsibilities on both government and universities to assure that the educational function is in fact nourished.

I would certainly point out that universities are the home and center for our cooperative extension programs, thereby bringing the results of research to the potential users.

Let me, second, turn to basic research being the core of our universities. People define basic research in various ways. There are some rather standard definitions. Most people use the NSF definition and, by reasonable estimates made across the country, it has now become quite clear that our universities as a whole, and particularly our land-grant universities, wherein we find our cooperative extension programs and our agricultural experiment stations, do about 50 or 60 percent of their research as basic research, the rest being applied and developmental and some technology development.

It is also clear that basic research is one of the major things that fuels the development engine. It is the basic research in our agricultural experiment stations that infuses our applied and our developmental research with new concepts and tough questions. It is basic research that provides the new knowledge that accelerates our technology development, and it is basic research in our agricultural research sector that will permit us to build the multidisciplinary teams with scientists from outside agriculture—a point that I will return to later—to help solve the tough problems ahead.

Education of our students, as I mentioned, is the sole and unique responsibility of universities. To be effective, this education requires research of all kinds, but particularly I believe it requires basic research, because it is that basic research that provides the principles for application.

The difficulty, of course, comes when our universities are asked to do frankly more things than they have the resources to do. If we assert that they must do basic research, we must also recognize that in the agricultural sector certainly, and indeed in some other sectors as well but not to so large an extent, they must also do applied and developmental research. That sets up enormous strains within a university, inherent strains. It is made more difficult because, frankly, there simply are not enough funds to do these varied jobs.

I would like to suggest that one of the major elements of our Federal responsibilities for agricultural research is largely missing, and that element is a satisfactory competitive research grants program for basic research in agriculture. All of us know the history of this program. It started in 1978. Funds were taken from the Hatch funds, and that made a certain number of people rather angry, to say the least, and we have been recovering from that mistake ever since. We now have funds only up to the level of $17.5 million.

For any person who comes out of the NIH sector or the NSF sector, $17.5 million is not a sum of money that is really talked about very much. It is a small part of an overall funding program, and that kind of increase is very routinely given to otherwise very large programs. In our sector, we spent an inordinate amount of time talking about increasing that a half-million, $1 million, or $2 million. The real point is that $17.5 million does not begin to address the needs we have, even in small sectors of our agricultural research business, let alone addressing the broad sector. I will come to that in a minute.

You can read my text, but my conclusion is that it is absolutely essential that the competitive grants program for agriculture must be increased very substantially. There are several reasons for this. One is that at the present time, we really have no financial incentives to attract and hold the very best scientists in the country, to hold them in agriculture. It is very easy for them to go elsewhere, and they do so. In fact, we are losing a number of good scientists. Second, because the funding for the formula funds has been increasing so slowly—not nearly enough to keep up with the cost of inflation—the competitive grants can be seen as a significant supplement to the formula-funding programs.

Third, and very interestingly, I believe the competitive-grants programs can be viewed as the venture capital or the risk capital that one uses for a 2- or 3- or 5-year period to examine a new idea, to determine how much merit there is to that idea, to determine if there are some new directions, some new questions. Because of the base funding we then have in agriculture through formula funds, we have a capacity of folding the results from this venture capital into the formula funds as well as the State funds that nourish and support our State agricultural experiment stations.

So for all three of those reasons, it seems to me absolutely imperative that we increase very substantially our competitive grants program.

What would be some of the characteristics of a competitive grants program? I have listed 11. The first three would be characteristics that would apply to any competitive grants program. Let me summarize these briefly.

First of all, the competitive grants program should be designed to obtain the maximum interest from all competent scientists, regardless of original discipline—from all competent scientists, not just those in agricultural experiment stations, not just those in land-grant universities but those from universities all over the country.

Second, the program should be designed to elicit the most creative, innovative thinking and analysis. Let me give an example from Cornell. We have two sets of scientists: one in our department of animal sciences and one in our department of agronomy. One set in animal sciences is interested in the preservation of both embryos and semen. This is done through freezing techniques or cold techniques. The scientist in agronomy has been interested in the physiological effects of harsh cold stress. Those two scientists have been working basically side by side for 3, 5, or 8 years.

Very recently, this past year, because of a program we installed at Cornell with our own money, those two scientists have said they have something in common. So now we are getting the genius, wisdom, and insight of a plant scientist and an animal scientist looking at something called cryobiology. The fundamental biological phenomena are the same. Now, if we have programs that are simply designed as plant programs and others that are designed as animal programs, we set up an absolutely artificial barrier for scientists like that getting together on a fundamental biological consideration, such as cryobiology.

Third, even though we have mission-oriented agencies such as the National Institutes of Health and the USDA, our competitive grants program should not be subsumed to specific immediate problem-type interests of those agencies; they must take a much longer perspective, and I think it is fair to say that the NIH program has been successful in doing that, and the USDA program is becoming successful in doing that. I then go on to list eight more characteristics and let me just briefly go through these.

There should be a broad array of grant programs available. Some people call it from the beginning of one's career to the end of one's career. I would like to think of it a little more comprehensively, and I will describe that in a minute. Second, we ought to be encouraging multidisciplinary studies. You have received testimony from Dick Caldecott from Minnesota last week in which he very adequately lays out the McKnight experiment, which I think is very exciting, focusing on multidisciplinary studies.

I believe that a major characteristic should be that all funds in this competitive grants program should be allocated solely on a competitive basis, without regard for geographic distribution. To be candid, that sometimes scares some people, but it is very easy to deal with that. You simply ask the question, Do you mean to say you do not have scientists at your university that can compete? There is a long pause, and then they recognize that yes, they do have scientists that can compete. We all know that at every one of our universities there are a large number of scientists that can compete with the very best across the Nation. We simply have to give them an opportunity.

All the applications should be investigator-initiated and peer reviewed with all scientists in public and private universities, all research institutes, and all government laboratories eligible to apply. Let's see just who can get the grants, and let's get the best ideas. This program should be designed to be complementary with existing funding programs in the USDA, NSF, NIH, and other agencies. It should have a mission orientation, just like NIH's competitive basic research grants program has a mission orientation.

Last, but certainly not least, a program like this must be added to, not taken away from, existing funding programs such as formula funds. This program should not be a replacement or a redirection of those programs.

Let me illustrate what I mean by a comprehensive program, the so-called cradle-to-the-grave phenomenon. I do not really think cradle is too good a thing to call a predoctoral student, and I do not think grave is a good thing to call a rather mature research scientist, but some people call it that, and at least it is mildly descriptive. It ought to start at the beginning, with predoctoral students. There ought to be competitive fellowships for those; we should get the best and the brightest of those. It ought to go on and have the same kind of program for postdocs. There also ought to be training grants for establishing and nourishing new programs in new fields of study, such as cryobiology, the one I just mentioned.

Those three programs have been time-tested by the NIH and the NSF, and they work very well. There ought to be project support of at least four different kinds. The first would be for young investigators, a program initiated by NSF this past year and in fact used in previous years by NIH. It is unfortunate they do not allocate enough of those to the biological sciences, but we will work on that.

Second, there ought to be research grants of two different kinds: both individual grants as well as the multidisciplinary grants.

The fourth kind of project support would be research, career development awards. First of all, it recognizes outstanding scientists and second, there is enough money to give them a real base of stable long-term support so they can dig even more deeply into their basic research. There ought to be program support, and I understand that the Congress and other agencies are not overly enthusiastic about program support. But in the past, it has proved to be very valuable, particularly as research programs are being established, such as in the biomedical sciences. I would assert that we need program support in the bioagricultural sciences at this time, just as we had it in the biomedical.

Equipment grants. We have a very serious problem in obsolete equipment and also general research support, such as the biomedical research support grants. And last, I think we all ought to recognize that we must be retraining ourselves so that we should have senior postdoc fellowship and senior awards.

Without belaboring this point, let me suggest that we need considerably more competitive research grants programs than we have now. Last year, Congressman, we talked about the biotechnology program, and we thought it would be interesting if that did proceed a bit. It has, and that is a beginning, but that is only the biology of information. Now we need to go on to the biology of whole organisms. Then we need to go on to the biology that is involved in the ecology of our world and the environmental systems in which these organisms grow. Last, we must recognize that there are economic, social, and institutional aspects of our entire business.

Well, what would some of those numbers be? Last year, I said the number for biotechnology ought to be $70 million, which was four times the amount of money in the USDA competitive grants program at that time. It turns out, as I describe in the testimony, that this amount of money is only about one-fourth to one-sixth the amount of money we need to deal with just that topic. When we are dealing with things like organismal biology and ecological biology, we are clearly up to much larger numbers. I have estimated in here $100 million per year for just the organismal and ecological biology.

Those numbers might frighten us in agriculture because we are not used to them. They certainly do not frighten anybody who deals with NSF and NIH. The NSF budget is well over $1 billion. It needs a lot more in biology. What better way to get money into biology than through agricultural research? Lest we think that is too much money for the size of the sector, let me simply say that presently we are very significantly underinvestigating and underinvesting in agricultural research. At the present time, at most, we are spending just 1 to 2 percent of the gross wholesale value of our products for agricultural research. That is in comparison to areas like the higher technology industry, such as the chemical industries and pharmaceuticals, where it might be anywhere from 5 to 10 percent.

But even more importantly, the average annual return on the investment is 35 to 50 percent, clearly, the best buy investment in research going. So I think the case is clearly made, and I would be happy to answer any questions. Thank you very much.

[The prepared statement of Mr. Hullar appears at the conclusion of the hearing.]

Mr. **Brown**. Dr. Hullar, I apologize because I have to leave, and I am turning the chair over to Mr. Volkmer, who will handle it very well. I want to thank you for your testimony. It is right to the point. We did take up some of these issues last week, dealing with the nature of the competitive grants program, the levels that we might find desirable, and you have helped focus some more light on those issues. We appreciate it very much, and again I apologize for having to leave.

Mr. **Volkmer** [acting chairman]. The gentleman from Kansas?

Mr. **Roberts**. Thank you for a fine statement. I just think that everybody on the committee and everybody up here would probably appreciate the fact that you should have more money for basic research. The proposal for competitive grants, I do not think you would probably find too much disagreement with that. But we do have a big problem up here, and that is where do we get the money? It is very difficult for any program. All you have to do is go over on the floor and watch and see what happens when you try and push for these increases. Do you have any sage advice as to how we go about doing this?

Mr. **Hullar**. I suppose one observation is that the amount of money—let's just take biotechnology, even the $28.5 or $50 million—that is not a very large percentage of crop surplus moneys. The interesting thing about biotechnology, when we really find it being incorporated fully into our plant breeding programs, is that it will increase the efficiency, the cost-efficiency of production. Now, that may turn out to be bringing most benefits to the consumers, but it could well be bringing profit advantages to the producers. I think that is one observation.

The second is that it seems to me, we almost have to look at agricultural research as a matter of national necessity. Agriculture is the largest industry in this country. It provides a great deal to our balance of payments in the export markets. We are finding that we are under increasing stress in the export markets. So it seems to me that it is an important investment for our national economic security, and therefore it should be thought about when one is setting the budget ceilings, not be thought about necessarily after setting the budget ceilings. I think we really have to incorporate this into those earliest budget estimates, pursuant to the budget reforms of Congress in the past several years. It cannot be left until later, it seems to me. It is too important.

Mr. **Volkmer**. I quite agree that we need to maintain, if not increase, basic research, especially in the agriculture area. We will take that into serious consideration next year when we take the legislation up again. So I want to thank you for being here today.

Our next witness is Dr. John Brand, associate dean, College of Agriculture and Natural Resources, University of Connecticut. Dr.

Brand, your statement, along with all of the previous statements, will be made a part of the record. You may either review it in full or summarize it, however you so desire.

I am going to be leaving, like the gentleman from California. It is not that we do not want to stay for your testimony; it is because we have other things going on at the same time. In a few minutes I am going to have to leave and let the gentleman from Virginia take over the Chair. You may proceed.

STATEMENT OF JOHN P. H. BRAND, ASSOCIATE DEAN, COLLEGE OF AGRICULTURE AND NATURAL RESOURCES, UNIVERSITY OF CONNECTICUT, AND CHAIRMAN, RESIDENT INSTRUCTION COMMITTEE ON ORGANIZATION AND POLICY, DIVISION OF AGRICULTURE, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND GRANT COLLEGES

Mr. **Brand**. Thank you, Mr. Chairman.

In addition to being associate dean of the College of Agriculture and Natural Resources at the University of Connecticut, I am also chairman of RICOP, the Resident Instruction Committee on Organization and Policy of NASULGC, the National Association of State Universities and Land Grant Colleges.

I am pleased to accept your invitation to comment upon critical higher education issues facing the food and agricultural science and education system. The members of the resident instruction section join me in expressing appreciation to this committee for including higher education in the scope of these oversight hearings, and I welcome this opportunity to provide testimony to complement that which I gave on February 7.

The joint council, in its report fiscal year 1985 Priorities for Research, Extension, and Higher Education, a report to the Secretary of Agriculture, recommended 8 national priorities from 24 that had been recognized. Scientific expertise development was ranked second in their recommendations. Basic biotechnology research was given the highest priority. It is, therefore, not unexpected that the higher education concerns of RICOP deal largely with issues associated with the development of the food and agricultural sciences.

RICOP's concerns regarding the academic community's capability to provide the Nation's food and agricultural scientists, managers, and technical professionals stem from eight basic issues. One, the decline in scientific literacy of high school students; two, the fact that students entering colleges of agriculture have been demonstrating lower SAT scores, while those going into schools of engineering are increasing; three, by 1991, we may expect 20 percent fewer individuals of college age; four, a shortage of college graduates with expertise in food and agricultural sciences is predicted throughout this decade; five, ongoing federally sponsored graduate fellowship programs in the physical and health sciences have been quite instrumental in attracting top scientific talent. As a result, food and agricultural sciences graduate programs are finding it increasingly difficult to attract top-quality students.

Of the approximately 1,000 doctoral degrees awarded in the United States, about 38 percent are awarded to foreign aliens, of which only 1 percent remain in this country. In the next decade, we will experience unusually high numbers of retirements of college of agriculture faculty. Eight, colleges of agriculture have experienced a serious deterioration of their capacity to educate highly qualified scientists and professionals. Inadequate investments for faculty, facilities, and equipment have seriously eroded program quality.

In an effort to address these issues, RICOP has strongly supported the food and agricultural sciences national needs graduate fellowships, which Dr. Carter had mentioned previously in his testimony. We had recommended an appropriation of $10 million for fiscal year 1985. These fellowships represent a dedicated and committed program for increasing agricultural scientific expertise in priority specialization. We continue to believe that these superior fellowships of $15,000 will give us a competitive edge in efforts to attract high-achieving students.

However, it is often argued that significant proportions of USDA funds, purported at times to be as high as 25 percent, provided through State agricultural experimental stations at land-grant universities, give adequate redress to expertise shortages and negate the need for graduate fellowships. However, I believe the evidence fails to support this contention.

I have included in my testimony a table showing assistantship and fellowship support funds for graduate students in agriculture and natural resources provided through State agricultural experiment stations at land-grant institutions. The figures reveal that in 1983, 3,729 graduate students received support. However, the fund support averaged only 0.36 of every full-time equivalent graduate student. These data are based upon a joint RICOP-ESCOP graduate student survey taken in the fall of 1983.

If a comparison is made of the dollars of Federal support distributed through State agricultural experiment stations with the total fiscal year appropriations in each fund source, it is revealed that relatively small proportions of allocated USDA funds are directed to graduate-student support. In fiscal year 1983, $149.3 million of Hatch funds were appropriated; only about $8.2 million were provided for graduate student support—5.5 percent. In the area of competitive grants, it amounts to 3.3 percent. The last category should read "competitive grants."

Only an average of 4.3 percent of the appropriated funds, including Hatch, renewable resources, McIntire-Stennis, animal health, and CSRS special grants, and competitive grants are directed to graduate-student support through agricultural experiment stations. It should be noted, however, that some USDA funds are distributed through research units other than agricultural experiment stations.

Unless a part of the research funds are dedicated specifically to graduate student support, there is no assurance that USDA funds—whether they be Hatch, McIntire-Stennis, or renewable resources—will in fact be utilized to attract and support graduate students, nor is there any assurance that the array of critical expertise shortage areas will be addressed. The justification for a continuing strong program of food and agricultural sciences national need graduate fellowships remains clear and viable.

We believe continued appropriations are needed to enable this program to achieve its stated objectives.

Assistant Secretary O.G. Bentley, in an article "Forces Reshaping Agricultural Research in Educational Institutions," published by the Farm Foundation, commented upon emerging trends that will affect agriculture's future. The one trend he commented upon was the recognition that agricultural manpower is crucially important to the security and well-being of this country. Our colleagues must take aggressive leadership in recruiting qualified undergraduates and expanding graduate education.

We believe the Graduate Fellowship Program is responsive to this call for action. Evidence continues to mount each year that we are going to have serious shortages of food and agricultural graduates. RICOP has recently reported that in 1983, enrollment at the baccalaureate level dropped another 6.4 percent, and those continued reductions are expected in the future.

Dr. Dwayne Suter, associate dean at Texas A&M and coordinator of the FAEIS program which has been supported by higher education program unit funds from science and education has recently issued a preliminary analysis of expected retirements of food and agricultural faculty. This data represents 75 percent of the 1862 land-grant colleges. A normal retirement rate might be that 14 percent of the faculty in a 5-year period would be retiring. The evidence shows that in the next 5-year period, we may see retirement rates far exceeding this.

In general animal science, 21.2 percent are eligible for retirement. In animal breeding and genetics, 26.7 percent; dairy processing, 28 percent; plant breeding and genetics, a key point in the new biotechnology, 20.6 percent. In climatology and meteorology, an exceedingly important science to agriculture, 30.4 percent of the faculty are eligible to retire in the next 5 years. These rates, again, stem primarily from the greater than normal hiring that took place in the post-World War II years, and these figures do not reflect the great number of vacancies that currently exist.

There is growing evidence that supports Dr. Bentley's trend prediction that society would increasingly recognize that agricultural mindpower is crucially important to the security and well-being of this country. The program of the American Association for the Advancement of Science, at its national meeting in New York, had a panel that addressed the question of shortages of agricultural scientists as a scenario for the future. Speakers included Dr. Bentley, who talked on Federal responsibilities; Dean Kunkel from Texas A&M who talked on projected needs; Mr. Roland Hendrickson, the vice president of Pfizer and president of the firm's agricultural division, who presented a talk on agricultural scientists for the 21st century, an industry perspective. Dr. Lawrence Boger, president of Oklahoma State University, was prepared to deliver a talk on the capacity of U.S. colleges and universities to prepare agricultural scientists for the future, but was unable to attend because of flight complications.

I believe some of their quotes would be of interest. Dr. Bentley indicated, "Clearly, the strength of U.S. science——"

Mr. OLIN [acting chairman]. Excuse me, Dr. Brand. I was just wondering whether it might not be appropriate for us to receive the report with these quotations and read them separately. If you could, summarize the conclusions you reached from them, if you don't mind.

Mr. **Brand**. I will, sir. I think the quotes indicate that there is an awareness in the academic, and Government, and industry that there is a need to maintain a steady flow of students from the undergraduate level through the graduate.

Your committee asked how title XIV might be amended to encourage State or private matching of higher education grants. We believe the extant language is sufficient to permit such matching. Section 1417 does provide for competitive and noncompetitive grants, and they may be made without regard to matching funds. The innovative proposals are forthcoming, can be forthcoming, and I think I would like to comment a bit further about that to indicate that we have taken steps.

I have indicated various recommendations for title 14 changes, and I won't go into those. I would indicate that the proposed addition to section 1402 is taken from the joint council's summary, and I think that statement would indicate a greater awareness of the recognition of the vital need for human capital.

The committee has also asked what USDA can do, even without special appropriations, to disseminate the results of curriculum-faculty-development efforts. These two activities are part of the projects that have been instituted by USDA's higher education program unit. They have been designed to assure a steady supply of trained scientists. I have listed the various projects that have been funded. The publication for high school science teachers is a CAST publication directed to science teachers. The Student-Recruitment Program is designed to attract urban students into agricultural sciences, and that is supported at Ohio State. The FAEIS Program will be discussed by Dr. Suter at Texas A&M. Another program in faculty development is headed by Dean Campbell at the University of Illinois, and Dr. Goecker at Purdue has received support from the higher education programs unit to develop a national network project to attract and develop excellent scientists. Again, it is aimed at the high school level to attract students to recognize the challenges and the opportunities that exist in agriculture.

Another project that I am vitally concerned with is the undergraduate curriculum assessment and development project. This project stems from an assessment in 1982 in which industry and academic leaders determined that a key priority item was the renovation, the modification, and improvement of agricultural curricula. An assessment was made of the needs, and the areas in which course development is being pursued are courses in agricultural systems analysis, problem-solving, ethical and public policy aspects of domestic and international agricultural systems, and leadership development.

The project on curriculum assessment was funded initially with a $40,000 grant from the higher education programs unit. Since then, we have received additional funds from the Exxon Foundation and the R.J. Reynolds Tobacco Co. These are matching funds that were not a prerequisite to the original grant from USDA. These funds now have become seed money. We are now currently attempting to raise $2 million in additional funds, and we have received considerable encouragement from Pfizer Corp. in our efforts to gain that additional funding.

Those funds will be used in each of these course areas to develop course materials, to conduct faculty training sessions, and to evaluate the effectiveness of those materials. A 6-week training program will be established in each of the areas to train faculty from both land-grant institutions and non-land-grant institutions.

Workshops, conferences, training sessions, and publications will be some of the methods used to disseminate information from these projects. In some instances, funds have been established and have been set aside. In others, we will have to seek industry support, and we are optimistic that we can receive them. We will also utilize forums such as the RICOP meetings, NASULGC meetings, industry conferences, and regional conferences to disseminate the information, using meetings that are part of the agricultural community's way of disseminating information.

It should be noted that it is not likely that we would be at this stage of development in interest, awareness, and commitment to the solution of the expertise-shortage problem if it had not been for the funding that has come from the Higher Education Program unit. These seminal projects do promise a considerable payback on investment. However, academia, industry, the States, Congress, and USDA must recognize that Federal support under section 1417 will be necessary to develop comprehensive strengthening programs that will address the needs for faculty development, curriculum improvement, student recruitment, and equipment and facilities improvement.

Dean Charles Hess, when he testified before the House Committee on Science and Technology, commented upon the difficulty of maintaining laboratories and instrumentation to keep up with industry. He noted that in biotechnology, venture capital is flowing into firms to move into biotechnology. But he emphasizes that the equipment needs are great at the university level, not only for research where it is critical to attract and retain scientists of the highest caliber, but is equally important in the training of undergraduate and graduate students. At some point, we must renovate and improve teaching laboratories within our institutions.

In response to this need and at the bequest of the joint council's higher education committee, RICOP is developing a task force in cooperation with AASCARR and representatives of other food and agricultural organizations to develop supporting evidence for congressional support of strengthening grants. This report would parallel the Human Capital Shortages brochure, which I know you are familiar with, which became the basis for our drive to receive funding for the competitive fellowships.

Congress has designated USDA as the lead agency in the Federal Government for the food and agricultural sciences and emphasized teaching as a direct mission of the Department. The Department must provide leadership to bear upon the threat of human capital shortages. Certainly, this leadership must be shared by academia and industry. However, the Department can, through its influence, serve as a coordinator and a catalyst to bring about awareness, understanding, and action, and the Secretary's challenge forum is an excellent example of what can be done. The pilot projects of the higher education program unit are other examples that have *brought together academicians, Government leaders, and business*men in a common cause, the improvement of higher education in the food and agricultural sciences.

I would like to recognize that the progress that has been made has stemmed largely from two professionals and one secretary in the higher education program unit in science and education. Certain projects such as the FAEIS project are just beginning to bear fruit. We would hope that the Department will recognize the need to continue to support the further development of this project and others generated to enhance the Nation's food and agricultural science teaching programs.

We cannot presume that the availability of sufficient numbers of highly trained and talented scientists, managers, and technical professionals will continue unless we provide support and incentives to bring about that result. RICOP stands prepared and ready to work cooperatively with other members of the agricultural community.

Thank you, Mr. Chairman. I would be pleased to answer any questions.

[The prepared statement of Mr. Brand appears at the conclusion of the hearing.]

Mr. **Olin**. Thank you, Dr. Brand, for a very complete statement.

Mr. Roberts, do you have any questions?

Mr. **Roberts**. Yes, Mr. Chairman.

I would like to thank Dr. Brand for a very fine and comprehensive statement, especially the specific recommendations you made on behalf of RICOP to the amendments of title XIV. I can assure you that members of the subcommittee will be going over those recommendations with a fine-tooth comb. With the leadership of the chairman in the field, which is second to none, we will be taking them very seriously.

I would like to be the devil's advocate here, just for a brief moment. I am harkening back to your statement on page 2, where you go down a chicken-little kind of thing with regard to agricultural scientists and agricultural professionals and people involved in agriculture, which I can assure you is next to motherhood in my country, and my land-grant institution. You say more or less that they are not as bright, and they are not as many, and they are not as motivated, and they are not as well educated. Other than that, we are doing fine.

Is there any other reason you can think of? I have a pet theory on this, and I am leading up to it. Is there any other factor here that you see playing? I am a little concerned about why our people are scoring lower on SAT tests and things of this nature in regard to agriculture.

Mr. **Brand**. I think it is not because we do not have some very extremely talented people within our colleges of agriculture; we do. But the facts do indicate that the quality of students, based on SAT scores, has declined. I think it is a question that we have fewer students that are of college age. There is considerable opportunity in fields such as engineering and business. The salaries are very high in those fields, especially in engineering. I think we are faced with the difficulty that society has not provided sufficient information, and this includes not only academic institutions but industry and

Government, to make parents and students aware of the opportunities.

A large segment of the population is not aware of the challenges, the career opportunities, that exist in agriculture. There are still too many people that think of agriculture as farming and ranching. The one quotation from Dean Kunkel is on the fact that the National Merit Scholarship, when it refers to agriculture, only defines farming and ranching. It is an honorable profession with great opportunity, but it has——

Mr. ROBERTS. I am not too sure about that great opportunity.

Mr. BRAND. I think there still are opportunities in farming, but I think for a great number of students—in the State of Connecticut, we have less than 4 percent of our freshmen that have had an agricultural background—but probably 80 percent find employment in jobs related to the food and agricultural industries. In science and education, there are opportunities.

Mr. ROBERTS. But isn't that where the money is? I think that in large part we are suffering from a farm income, a cash flow, a credit crisis all throughout agriculture on the producer's side, and people are finding much higher-paying jobs elsewhere.

Mr. BRAND. At the time in the seventies when there was considerable media coverage of the concern about environmental quality and a return-to-the-earth movement, we had a tremendous increase throughout the United States in the number of students that entered the plant science field and renewable natural resources. I attribute, in large measure, the great increase in enrollment within those fields because of the tremendous media coverage of the problems within those areas and the need to correct them. That affects high school guidance counselors, but more importantly it educates parents who are still the one group that influences what students do beyond high school if they go college. It is not the guidance counselor, it is the parents. If the parents recognize that there are opportunities, and either encourage or do not dissuade a student, they will pursue agricultural careers.

But they need the information. They must understand the opportunities, and that is one reason why the CAST publication, going to high school science teachers and high school libraries, is one way, a small way, of bringing some information to the public in which they can be better informed.

Mr. ROBERTS. I am all for the CAST information. I think that is a very worthwhile thing. As a strong supporter of CAST, I think it is just an outstanding effort in that regard.

But getting back to my pet theory, the answer from you should be yes by the way. Is it not a case that as of today, with the way things are in agriculture and more or less with people going to school for 4 years, that there is a tendency on the part of people who are majoring in these courses to go out in fact and get a job, and that they are more inclined to do that as of today than perhaps they were back in the seventies, and that part of the answer to this question is then how can we reopen that back door to further study?

This subcommittee has explored this issue to a great degree—and I must admit, this is my pet theory, so that is why I am saying that the answer is yes. I think one of your efforts here, and a very successful effort, is your campaign to raise funds from private industry, which you are doing. It seems to me that if a graduate can get paid *x* dollars , as opposed to what they can face going back to school for another 2, 4, or 6 years, they are going to get paid *x* dollars. We need to encourage them to come in through the back door to further that education.

Now, am I off base, or am I on point?

Mr. **Brand**. We certainly are losing students that have degrees at the baccalaureate level in agricultural engineering or agricultural mechanics. It is very difficult to persuade those students to go on for a master's degree, because they have the same opportunities as engineering students: very high initial salaries to enter those disciplines. The same thing holds in nutrition. I was speaking with my nutritional sciences department head. We are losing students, extremely qualified students, at the end of the baccalaureate degree. They are getting jobs, they are marrying, they want to go back to school, but they cannot go back to school with a husband and a child or——

Mr. **Roberts**. With all due respect, you are not going to stop that by having the parents read something about the environment in the newspapers. How widespread is the industry interest in this? Are you finding industry as vitally interested in this?

Mr. **Brand**. We are finding that there are key leaders among the agricultural business leadership that are interested. The support is coming slowly, but we have just started our campaign. We feel we have enough support in all the projects that I have described that have been supported.

Mr. **Roberts**. Pardon me for interrupting. You made a statement here in the back part of your testimony, I think it was page 17, in regard to the lack of up-to-date equipment. Do we have enough tax breaks to private industries to donate these kinds of equipment to our laboratories and things of this nature? I think we ought to explore all sorts of ways to get industry more involved in this process.

Mr. **Brand**. I think there are examples throughout the land-grant colleges where industry has contributed equipment, computers and other laboratory equipment. But again, it is not sufficient to meet the needs of all the colleges and schools of agriculture across the country.

Mr. **Roberts**. I am not implying that is the case.

Mr. **Brand**. But I think we are increasingly doing that. Unfortunately, the equipment is not always state-of-the-art equipment. Our teaching laboratories, I think when we collect the data, we will be ashamed that we have permitted laboratories to deteriorate to the state they have. I think all too often we look at some of the top 10 or 15 colleges of agriculture, including the one in your own State—one of the finest in the United States—but there are many others that have not received the same degree of support from their State legislatures.

Mr. **Roberts**. We have not received enough support. I can go on record as saying that.

You are spending $5 million, in terms of the program that trains, according to my notes here, 300 Ph.D.'s every 3 years. Let me ask you, how large would the competitive fellowship grant program have to be to significantly affect the supply of graduates as you have described in your testimony?

Mr. BRAND. The original program when it was proposed was for about $10 million a year for 11 years. This was a terminal project, where the thought was that in an 11-year period, we would meet the needs to provide the expertise within critically short areas. It would reach a peak midway through and then the fund needs would decline. But it would average $10 million per year. So that students would be supported for a period of 3 years, but at the end of 11 years, this program as originally proposed would come to a halt.

That is why we received the appropriation of $5 million. We originally requested $10 million because we feel the program deserves funding at the $10 million level. But certainly with the appropriation of $5 million, we would hope that there would be a recognition in Congress to retain that program. We feel the response will be great to this program, and it will direct extremely talented individuals, will attract them into the fields that I think everyone is recognizing are critically short areas, agricultural engineering for one. It is very difficult to find a Ph.D. agricultural engineer to do research. There are only 17 institutions in the country that are providing Ph.D.'s. A good master's student in agricultural engineering is going out and taking a job, and they are being paid more than most of our assistant professors.

Mr. ROBERTS. I think that was my point when I started off, and I think that is a good place to end it. We have a vote, Mr. Chairman. I appreciate, sir, your response to my questions and your testimony. Thank you, Mr. Chairman.

Mr. OLIN. Thank you very much, Dr. Brand.

I would like to call the hearing in recess temporarily. We have to go over for a roll call vote. Dr. Suter is here. Stand by. We will be back in 10 or 12 minutes, and we will reconvene at that time.

[Recess taken.]

Mr. OLIN. Our next witness is Dr. Dwayne Suter, associate dean for instruction, Texas A&M University, and he is accompanied by Dr. K. Jane Coulter, from the Office of Higher Education, U.S. Department of Agriculture.

STATEMENT OF DWAYNE A. SUTER, ASSOCIATE DEAN, COLLEGE OF AGRICULTURE, TEXAS A&M UNIVERSITY, ACCOMPANIED BY K. JANE COULTER, DIRECTOR, OFFICE OF HIGHER EDUCATION, U.S. DEPARTMENT OF AGRICULTURE

Mr. SUTER. Thank you, Mr. Chairman, for inviting me to participate in these hearings. I wish to address certain specific higher education issues highlighted in the draft charter. In particular, I wish to discuss the need for the development of a comprehensive Food and Agriculture Education Information System [FAEIS] and potential cooperation between land-grant institutions and private firms in the development and distribution of computer software appropriate for the agricultural sciences.

Within the Federal partnership of teaching, research and extension, only higher education does not have a national information management system. As outlined in the Food and Agriculture Act of 1977, the secretary shall keep informed of the development in and of the Nation's need for research, extension, teaching, and manpower development in the food and agriculture sciences and represent such need in deliberations within the Department of Agriculture, elsewhere within the executive branch of the U.S. Government and within the several States and their designated land-grant colleges and universities, agriculture and related industries, and other institutions and groups.

The initiation of the development of FAEIS is thus a manifestation of the will expressed by the Congress in the Food and Agriculture Act of 1977. We are pleased to be here today to give you a brief progress report and to discuss plans for the continued development and refinement of FAEIS. I would like to take this opportunity at this time to express appreciation for the financial and leadership support provided thus far through the USDA, ARS Office of Higher Education, Dr. K. Jane Coulter, Director of the Office of Higher Education programs sitting to my right, who is with us here today, who has provided outstanding leadership and continual guidance and support in this endeavor.

In my written testimony, I have discussed the deficiency of existing databases, which include information on food and agriculture, such as a lack of specificity, incompatibility for competitive purposes, a lack of timeliness, and being available only in a fragmented form from different agencies. As an attempt to address these deficiencies, the purpose of FAEIS is to provide empirical information for effective planning and coordinating efforts, directed toward supporting and strengthening higher education in the food and agricultural sciences.

FAEIS is envisioned as a comprehensive system of food and agriculture information that would include new databases, as well as databases from which data are currently collected. By centralizing the information into a central system, FAEIS would allow for a centralized information retrieval with the following comparative advantages over the existing, fragmented data availability: One, less timeconsuming to acquire the data; two, be less expensive to utilize the system; and three, less complex for retrieving needed data.

In addition, FAEIS would be a dynamic system, amenable to revision or expansion as conditions and information needs change. FAEIS will produce a regularly scheduled series of standardized statistical tables and reports for subscribers. A sample prepared for home economics is given in the written testimony to illustrate something of the direction in which FAEIS is moving. It is an example of the type of table that can be either in hard copy or by electronic retrieval for those users who have the capability of retrieving it in that manner.

The data are only preliminary, since the targeted response rate percentage of 75 percent has not yet been achieved. The statistical tables represented are preliminary. The final report will be issued as soon as a 75-percent response rate is achieved, a goal which we hope to achieve in the coming months. We have set an approximate 75 percent response rate as our target goal for each of the reports. That is 75 percent of the targeted institutions.

Responses from those replying to the survey forms has been generally very positive. Recognition of the need to collect, analyze, report, and store information related to higher education in the agricultural sciences has been a leading factor in the response rate and timeliness. Advances in computer communications and technology will aid in the development and utilization of FAEIS.

We sincerely believe that we can continue to progress in meeting the mandate of the Food and Agriculture Act of 1977 to develop and deliver an efficient information management system for higher education in the agricultural sciences if the funding level is adequate and maintained at the appropriate level. I might add at this point, part of my other involvement at Texas A&M University is to serve on the chancellor's task force to develop an office automation system for all of the agencies and universities within the system, which include 25 off-campus centers, and also to serve as assistant project director for the university to develop an integrated student record information system. So, much of my time at the present is devoted to this type of activity.

I appreciate very much the support of the Department and the opportunity to be involved in what I think is an extremely important effort and one that I believe will provide some very important input to the agricultural system. Thank you, Mr. Chairman and subcommittee members. I will be pleased to attempt to answer any questions which you may have. I have attempted to summarize and just hit highlights in the interest of time.

[The prepared statement of Mr. Suter appears at the conclusion of the hearing.]

Mr. OLIN. Fine. We appreciated the highlighting. I was just wondering if Dr. Coulter has anything that she would like to add at this time, or whether she would just as soon take any questions.

Ms. COULTER. No, sir. I think Dr. Suter has done an adequate job in answering the major issues of concern to the subcommittee. I might add, he certainly has done a very adequate job in trying to develop the FAEIS system.

Mr. OLIN. We certainly appreciate your coming here today, Drs. Suter and Coulter, giving us this update and also we thank you for your participation in this project.

Could you tell me a little bit more about how you think the cost is going to work out? I notice on page 10 of your testimony that the USDA has already put about $145,000 into development.

Mr. SUTER. Yes. Texas A&M University has contributed a little in excess of $20,000 to accelerate the development of this system. We feel very strongly that it is timely, that it is needed for our own institutional needs, so we have put in a major investment as an institution. We estimate that approximately $250,000 is needed for 2 years, and then we can draw back to a maintenance level of about $100,000 per year.

Mr. OLIN. That is $250,000 more for development?

Mr. SUTER. No, about $250,000 per year for a 2-year period would be the level which we would recommend to accelerate its development. Now, we can continue to develop it at the rate of what we have been receiving, of about $70,000 to $75,000 per year. It simply would take that much longer to develop it, and therefore delay the time in which it would be on line.

Mr. Olin. You think the maintenance would be about $100,000 a year?

Mr. Suter. That is right. That is what we estimate, as we begin to bring in all of the various national databases which would include millions of bits of data, and we would also then provide the capability of delivering and answering queries from Members of Congress, agencies, institutions of higher education, private industry, who are the ones that we anticipate will be calling on the system for information.

Mr. Olin. Do you think that the user fees will cover the maintenance cost?

Mr. Suter. I believe that would be possible in the long run, yes, sir.

Mr. Olin. Are you recommending that this proceed at the pace you are talking about, the $250,000 per year for 2 years?

Mr. Suter. That is what we are recommending in order to accelerate its being brought on line.

Mr. Olin. Mr. Roberts.

Mr. Roberts. Thank you, Mr. Chairman, and thank you, Dr. Suter and Dr. Coulter, for being so patient and taking the time to come before this subcommittee.

In 1980, the USDA made a higher education supply/demand projection. Were they in the ballpark? Was that an accurate supply/demand kind of situation?

Mr. Suter. Yes. We are in the process of updating that study. We just met with a panel from Washington State, representing other people across the country, to give an update of the Bureau of Labor Statistics and other data, and we anticipate that we will, on a regular basis, update those supply/demand estimates.

Mr. Roberts. Have you made any major policy changes or recommendations as a result of this, where you think you have made some improvements on these estimates?

Mr. Suter. We are continuing to refine the data, and our estimates, of course. When we get into large empirical models, in the initial run on them they are quite soft and do require, as in the field of engineering—I am an agricultural engineer and very familiar with the way in which supply-and-demand estimates are made in the field of engineering, some refinements that are based upon what the economy will do, how much lateral movement do we have between various academic disciplines. One job may be available to students of several different disciplines and perform that task very well. But we anticipate further refinement, as we gather student enrollment, employment, placement from our several colleges of agriculture and home economics, track them in the field as to their professions. We also envision, as I currently do with the American Society of Agricultural Engineers and the Institute of Food Technologies—and I am a professional member of each—tracking both the enrollment, the faculty, and the placement of those students. We would use those as a horizontal way of looking at our total matrix of information for refinement. In other words, it would be, as an accountant would say, a "double-entry" bookkeeping system.

Mr. Roberts. Thank you, sir. Thank you, Mr. Chairman.

Mr. Olin. I do not think I have any additional questions. We really appreciate your coming, Dr. Suter and Dr. Coulter.

The subcommittee stands adjourned.

[Whereupon, at 4:30 p.m., the subcommittee recessed, to reconvene at the call of the Chair.]

[Material submitted for inclusion in the record follows:]

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STATEMENT OF

LARK P. CARTER

DEAN OF AGRICULTURE

CALIFORNIA POLYTECHNIC STATE UNIVERSITY

SAN LUIS OBISPO, CALIFORNIA

ON BEHALF OF

THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES

AND

AMERICAN ASSOCIATION OF STATE COLLEGES OF AGRICULTURE AND RENEWABLE RESOURCES

HEARINGS ON

AGRICULTURAL RESEARCH EXTENSION

AND HIGHER EDUCATION

BEFORE THE SUBCOMMITTEE ON

DEPARTMENT OPERATIONS RESEARCH AND FOREIGN AGRICULTURE

U.S. HOUSE OF REPRESENTATIVES

WASHINGTON, D.C.

JUNE 12, 1984

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Cable Address: AASCU-Washington, D.C.

My name is Lark Carter. I am Dean of Agriculture at California Polytechnic State University, San Luis Obispo, California, most commonly referred to as "Cal Poly." Prior to taking this position I served for one year as Assistant Director of the Office of Higher Education in Science and Education, U.S.D.A., and prior to that as Associate Dean of Agriculture and Assistant Director of the Agricultural Experiment Station at Montana State University.

My testimony today will focus primarily on issues related to higher education in the food and agricultural sciences. It should be understood, however, that research and extension are intricately interwoven into these issues since most of the human expertise servicing these two important efforts are products of resident instruction programs in agriculture from across the country.

I am pleased to have this opportunity to present testimony on resident instruction programs which prepare professionals for Cal Poly's largest School and California's largest industry, Agriculture. Teaching is the number one priority at Cal Poly. We will have about 3700 students in our School of Agriculture next fall making Cal Poly one of the largest undergraduate agricultural institutions in the nation. We graduated over 800 students with degrees in agricultural disciplines last Saturday. I present these figures to illustrate that a significant portion of the agricultural expertise being educated in this country comes from institutions that are not land-grant universities.

Cal Poly, San Luis Obispo, is one of 65 public higher education institutions offering agriculture that belong to the American Association of State Colleges and Universities (AASCU) and its parallel organization, the American Association of State Colleges of Agriculture and Renewable Resources (AASCARR). Nearly 5000 degrees in agriculture and related areas are granted annually from these institutions. Their faculties include more than 1000 agricultural scientists, 75% of whom have doctorates. Nearly one-third of the bachelor's degrees awarded in agriculture in the United States are granted by AASCARR institutions.

These non-land grant and the land grant colleges of agriculture, in cooperation with the United States Department of Agriculture comprise a vital working team with a mission. Our mission is to develop and maintain a productive, efficient and competitive American agriculture by producing human resources with the expertise and skills needed by our nation's food and agricultural system. Because of the importance of this mission to the security and well being of this nation it is essential that an effort be made to develop cooperation and coordination among the agricultural teaching components of all of our agricultural universities and the United States Department of Agriculture.

Title XIV of the Food and Agriculture Act of 1977 Public Law 95-113 as amended in 1981 recognized the importance of the teaching component of the research, extension and teaching triad which has contributed so much to making American agriculture a world-wide leader. This legislation states, "The research, extension and teaching programs that support the food and agricultural system must be maintained and constantly adjusted to meet ever changing challenges. National support of cooperative research, extension and teaching efforts must be reaffirmed and expanded at this time."

This past year Congress, for the first time, appropriated $5,000,000 for graduate fellowships to attract capable, highly motivated students into professional areas in agriculture where human expertise shortages exist. This is a symbolic but important initial investment in the fulfillment of the mission stated above.

It is extremely important that as revisions are considered for Title XIV of the Farm Bill that language include teaching as an integral part of this legislation along with research and extension. I repeat, it is the agricultural teaching component that attracts and educates a vast majority of the research scientists and extension personnel. It is completely inappropriate and unacceptable to exclude this vital part of the body.

In addition, it is essential that appropriation language be retained authorizing funding of the Food and Agricultural Science National Need Graduate Fellowships Program. In addition, funding authority should be retained for grants:

"to strengthen institutional capacities to respond to state, national, or international educational needs in the food and agricultural sciences;"

"to attract students and to educate them as needed in the food and agricultural sciences, and to attract needed professionals to provide for their professional improvement in the food and agricultural sciences;"

"to design and implement innovative food and agricultural education programs."[1]

It is important that the language of this part of the bill be written in such a way as to allow for support of both NASULGC and AASCARR institutions. Both groups of institutions are significant contributors to the agricultural expertise pool.

As the Joint Council on Food and Agricultural Sciences assessed "FY 1985 Priorities for Research, Extension and Higher Education," they focused on eight recommended national priorities in the following order:

1. Basic Biotechnology Research
2. Scientific Expertise Development

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[1] Title XIV of the Food and Agriculture Act of 1977 Public Law 95-113 as amended in 1981.

3. Communication Technology
4. Analysis of Price and Income Policies with Emphasis on Foreign Trade
5. Sustaining Soil Productivity
6. Human Nutrition Including Food Safety and Quality
7. Water Management
8. Forest, Range and Pastureland, Productivity Enhancement Including Multiple Use.

It should be noted that Scientific Expertise Development in the food and agricultural sciences was assessed by this body to be second only to the Basic Biotechnology Research as a national priority in their recommendation to the Secretary of Agriculture.

As one looks at priority issues identified by the Joint Council it is apparent that the need for continuing education opportunities for food and agricultural science faculty is becoming more and more important. For example, a faculty member completing the Ph.D. in 1964 probably did not learn now to operate a microcomputer. In fact, it is likely that this faculty member was not skilled at operating a typewriter or keyboard.

This is only one example of the need that exists among mid-career faculty members for gaining new knowledge and skills to continue to be effective teachers as well as researchers or extension specialists. Strengthening grants,

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as authorized by the current Farm Bill are going to have greater and greater potential as a means of "strengthening institutional capacities to respond to state, national or international educational needs in the food and agricultural sciences." These grants would be of particular importance to AASCU agricultural colleges and universities which do not have the benefit of Hatch Act and Smith Lever Act support. These grants would provide all agricultural universities much needed resources to redirect existing programs and develop new initiatives responding to emerging technological developments and emerging human resource needs in agriculture.

The Higher Education Programs Office, Science and Education, USDA, is to be commended for their efforts to develop a much needed information system on higher education in agriculture. When this comprehensive national information system is fully established it will provide ready access to data that will allow for improved program planning, better coordination, more efficient administration and more meaningful evaluation of instructional programs across the country.

This information system known as the Food and Agricultural Education Information System (FAEIS) is being developed jointly by the Higher Education Programs Office, USDA and the cooperating land grant and non-land grant institutions. It will provide data and information such as current and projected student enrollments, degrees conferred, teaching programs, faculty, graduate student support, employment demand for graduates, etc. FAEIS will, for the first time, provide accurate data on the total system of higher education in agriculture in the United States.

The revised Farm Bill should include authorization for support of this valuable service. It is anticipated that FAEIS will go on line in the fall of 1984. Texas A & M University is assisting with implementation of this system.

I would like to address priority three from the national priorities of the Joint Council on Food and Agricultural Sciences, Communication Technology. The technology involved with gathering, analyzing and disseminating information is developing at an extremely rapid pace. Both resident instruction and cooperative extension must become increasingly alert to the potential uses of modern computer technology and telecommunications for increasing agricultural productivity and efficiency within the total agricultural system.

Computer use has moved into most aspects of our agricultural research, extension and teaching network. They are now easily operated by non-programming experts, have affordable price tags, are adaptable to hundreds of possible applications and, once mastered, are capable of increasing the operator's efficiency and effectiveness.

The development of this new technology has created new opportunities for higher education in agriculture. It has also created problems for us to solve. A high percentage of the high school students coming onto our campuses have been exposed to and have experience with computers and are expecting to acquire more skills at the university. Most universities do not have sufficient numbers of staff with this expertise to provide this education.

From the other side of the fence, the agricultural industry with which we work very closely, also expects to be able to come to us for help. For example, at Cal Poly we recently contracted with the California Milk Advisory Board to use student interns in the field to collect data and create a data base for the Board. This, of course, must be done under the supervision of a professor who is knowledgeable in this field and has acquired computer skills. We have many requests for this kind of assistance, more than our faculty can respond to. We have people with the expertise but as a non-land grant university no extension funds are made available to provide these services. We do the best we can, usually on an overload basis, to serve these needs, but we turn down more requests than we are able to respond to.

At Cal Poly we are dealing with the transition to the information age in a number of ways. We are providing in-service computer education programs for high school vocational agriculture teachers throughout the state. Through our Vocational Education Programs unit, an on-campus supply house for visual aids and computer programs, we are providing useful, workable "debugged" software for the vocational agriculture teachers in community colleges and high schools. This software has been developed in such a way that these teachers are able, after additional training which we provide, to teach computer skills at their schools. Our faculty also are major providers for Photocom Productions, a private industry software marketer.

The ongoing need is for the development of additional software that has been screened by faculty with the appropriate expertise to assure that agricultural teachers at all levels are able to acquire and use professionally credible, debugged, easy to use, software. This is becoming increasingly difficult to do, because we simply do not have staff, on an on-going basis, to do it. However, we are doing the best we can with the resources available.

Cal Poly in cooperation with the Computers in Agriculture organization provides speakers and hands-on workshops for seminars held for the agricultural industry. In fact, Cal Poly will jointly sponsor with this organization a computer show and trade fair on our campus in November, 1984. This will provide a hands-on opportunity for people from the agricultural industry to compare and evaluate software that would be applicable to their own particular areas, i.e., herd management for animal scientists or a pesticide data base for those in plant protection.

We find that our greatest constraint to progress in the general area of communication technology is that of human resources. To address this problem we have arranged a joint appointment between the Computer Science Department and the School of Agriculture. Faculty in-service computer education classes are offered twice a year to provide skills and updating of skills to the existing faculty.

Another way we are attempting to adapt to the shortage of computer education faculty is to use faculty from the various agricultural disciplines who have acquired computer knowledge and skills to teach the beginning level computer class for the Computer Sciences Department. This frees the limited number of computer sciences faculty to teach more advanced courses. This has worked quite well at Cal Poly this past year and will be continued next year.

In addition, our faculty are being encouraged to develop computer applications in their classes either as a part of the existing course or by developing new courses.

The problem being adddressed is that of a nationwide shortage of people with qualifications as agriculturalists and with skills in computer use. It appears that this need will have to be addressed, in the short run, by retraining and additional training of existing faculty.

In summary, I would like to make the following recommendations:

1. I recommend that language be retained in the revision of Title XIV of the Farm Bill designating the U.S. Department of Agriculture as the lead agency of the Federal Government for agricultural research, extension and teaching in the food and agricultural sciences. The cooperative relationship in research, extension and teaching that has been developed among the land grant and the non-land grant universities and Science and Education, USDA, must be maintained and strengthened.

2. I recommend that any revision of Title XIV of the Farm Bill include a continuation of authority to appropriate funds for strengthening grants and for Graduate Fellowships to support the teaching component of the agricultural research, extension, and teaching network.

3. I recommend that any revision of Title XIV of the Farm Bill be written in such a way as to include AASCARR institutions as well as Land Grant institutions as those eligible to receive support under this legislation.

4. I recommend that the USDA continue to support the development, implementation and continuation of the Food and Agricultural Education Information System.

5. I recommend that the USDA, Science and Education, work cooperatively with state research, extension and teaching units to address the high priority issues identified by the Joint Council on Food and Agricultural Sciences. I especially focus this recommendation on priority number two, Scientific Expertise Development in the Food and Agricultural Sciences.

6. Finally, I recommend that the membership of the Joint Council on Food and Agricultural Sciences maintain a minimum of two representatives from among the AASCU/AASCARR institutions which contribute so greatly to the development of agricultural expertise across the nation.

STATEMENT OF
HENRY A. WADSWORTH
DIRECTOR
COOPERATIVE EXTENSION SERVICE
PURDUE UNIVERSITY

AND

CHAIRMAN
EXTENSION COMMITTEE ON
ORGANIZATION AND POLICY (ECOP)

BEFORE THE
SUBCOMMITTEE ON DEPARTMENT OPERATIONS,
RESEARCH AND FOREIGN AGRICULTURE
COMMITTEE ON AGRICULTURE
U. S. HOUSE OF REPRESENTATIVES

JUNE 12, 1984

Mr. Chairman and members of the Committee: I am Henry Wadsworth, Director of the Cooperative Extension Service at Purdue University and Chairman of the Extension Committee on Organization and Policy (ECOP) for 1984.

I appreciate the invitation to make a statement on behalf of the nationwide Extension Service system. In view of earlier testimony before the subcommittee I will direct my comments to a few specific areas where it appears further discussion might be helpful.

Throughout the course of the hearings much attention has been given to change; the inevitability of change, the speed of change, adapting to change. It is clear that everyone is involved in change, learns how to cope with changes and where relevant make those changes that enhance income earning capacity, increase the availability of needed services and make a more desirable life style. But given what we know about change, formal education in secondary or post secondary schools is only the beginning, the preparation for a life of continuing learning. How will we choose to enhance this learning? As one alternative, people would be expected to make their own adjustments to change with a variety of "safety net" programs provided for those "fall outs" who are not able to make appropriate changes of their own accord. At the other end of the continuum are the extensive sets of legislated or mandated changes requiring particular behaviors and implemented by various regulatory efforts. In between these extremes is the alternative embodying a life-long learning approach that encourages people to continue to assimilate knowledge about change, develop the ability to make decisions about the appropriateness of change and carry out the actions to effect desired change. I am not so naive to think that we won't need "safety nets" or "regulations" to handle extreme situations but I am convinced that a system relying upon an educated and informed public is the most cost effective approach and will lead to greater realization of human potential.

I believe the nationwide Extension Service has much to contribute in this regard. Our greatest ability is to help people make informed changes. Extension is in a unique position to do this because of its relationship with capable federal and state research colleagues. The value of the work of these colleagues is largely lost if discoveries are not applied. There is no better way to help people evaluate change than for them to see the results of research that has introduced and compared the results of alternative changes. The research-extension relationship is crucial.

The relationship of Cooperative Extension to people is aptly contained in a quote of Dr. Frank H. T. Rhodes, President of Cornell University, i.e. "knowledge applied, knowledge multiplied and knowledge trusted." It takes cooperative federal, state, county relationships to achieve this goal. It is the tie between the university, county agents and volunteers which multiplies the knowledge and makes it available to the people in every county of this nation and establishes the trust and confidence in the knowledge received.

Our job today is to use the past in planning for the future. Previous testimony has adequately documented the dramatic increase in number and variety of audiences who seek educational assistance from the Extension Service while noting that resources devoted to extension's educational work have not experienced a comparable increase. My remarks will be limited to three major topics:

1) State's views regarding "Extension in the 80's" recommendations;
2) The impact of electronic technology on extension;
3) ECOP recommendations on formula funding.

EXTENSION IN THE 80'S

There has been much discussion of the "Extension in the 80's" report from a national perspective. I would like to make a few comments from my point of view as a state extension director. Among the many recommendations contained in this report, there are a number that are particularly important from a state's point of view.

The federal, state, local partnership between USDA, the land grant institutions and county governments creates a unique educational organization with unusual capabilities to address problems of national importance that require education to stimulate local action. States are continually seeking ways to increase the effectiveness of their educational efforts and these recommendations will initiate and/or reinforce management actions in doing so. States also believe stronger individual partners will lead to more vital and dynamic partnerships.

States would also wholeheartedly agree with numerous affirmations of the value of the land grant system. In particular states would strongly support the conclusions that programming must retain broad flexibility at all levels for the Cooperative Extension system to remain relevant and responsive. This ability to be flexible and direct programming to important changes confronting clientele coupled with the ability to draw upon supportive resources at all levels is an absolute strength not possessed by any other state or federal agency. This flexibility in programming will be as important to successes in the future as it has been in the past.

The research base is also an essential contributor to educational accomplishments. The land grant colleges, with their respective Agricultural Experiment Stations and Cooperative Extension Services actively encourage research-extension interactions. Daily discussions occur between researchers and extension specialists located in the same department where they jointly consider food and agriculture concerns: "What are the problems?", "What do we know about them?", "What do we need to find out?", "Where else might information be available?", "How can we assist people with these problems?" The trust placed by people in their Extension Service, in particular their county agents and specialists, largely results from the fact that what we say, we know. We know because we have research observations and results about most phenomena that are observed. This permits us to explain the problem, its causes and the choices for ameliorating the problem. Extension also depends on other sources of reliable research based information including other university departments, as well as state and federal agencies.

In my viewpoint, the report needed to place more emphasis on the need to allocate greater resources to applied research and demonstrations. Much of current research is directed toward understanding basic concepts. Frequently there is a considerable gap in moving from laboratory results to field applications. Who will do the work to make such a transition possible in order to realize the full potential of the basic work? The State Extension Services could assume more of this responsibility if resources were available to do so.

State Extension Services concur with initiatives to improve program evaluation and accountability. Current plans by the federal partner will provide documentated results on five (5) major programs, elements of which are found in most states. In addition, states will undertake over 200 studies that evaluate programs in their own states. These will supplement national undertakings and should produce documented evidence of results obtained from programming that reflects both national and state priorities. This should build into a comprehensive overview of programming effectiveness.

ELECTRONIC TECHNOLOGY

There is widespread recognition among the states that we could better serve existing audiences and reach new ones by increasing our utilization of existing electronic technologies particularly computers and video systems. The significance of these developments led the Division of Agriculture to constitute an ad hoc committee on Electronic Information Delivery Systems. This committee prepared the following overview statement as guidance to institutions who are rapidly increasing their capabilities in electronic information delivery.

"A major responsibility of the Land-Grant University system is to diffuse among the people of the United States useful information relating to agriculture, home economics, natural resources and rural development. The basis of this mission is the Smith-Lever Act of 1914, numerous other Federal Acts, and state legislation in every state in the nation. The imparting of information on said subjects is to be through appropriate delivery systems. These responsibilities provide the basis of a Division of Agriculture statement on electronic information delivery systems.

The Agricultural Division of the National Association of State Universities and Land-Grant Colleges (NASULGC) believes our nation is on the threshold of revolutionary change in information delivery. Electronic information delivery promises significant changes in all information distribution systems but is of paramount importance to information delivery systems which are time critical. For the Land-Grant University and cooperative extension to perform their legal mandate it is imperative that they adopt appropriate electronic delivery capacities to enhance their operating efficiency and educational effectiveness. NASULGC also recognizes the desirability and the importance of the private sector in information generation and delivery. Historically, the private sector has dominated information delivery through many mediums -- newspapers, periodicals, radio and television, and in the emerging use of computers and other electronic devices. The Land-Grant Universities recognize the vital contributions of the private sector and will continue to use the media which are available to effectively carryout the university mission.

We encourage all Land-Grant Colleges and Universities to cooperate with the private sector computer systems in the delivery of information to clientele as it becomes physically and economically feasible. Further, we encourage the Land-Grant Universities to not directly duplicate services that are available in the private sector.

Critical to successful agricultural computer programs is relevant software for problem solving. The principal knowledge generator for American agriculture is the Agriculture Experiment Station and the Cooperative Extension Service of each state in cooperation with the U.S. Department of Agriculture. Thus, these institutions must assume the responsibility of translating research and information into software packages applicable to family farms and related agriculture production and marketing institutions. Land-Grant Universities have fairly consistent policies regarding ownership rights for educational materials. Rights of the faculty/staff author are clearly recognized and preserved. Institutions must determine how to make their software available to the public and private sector within these established policies."

The Extension Committee on Organization and Policy recognized the increasingly important roles of computers in a report released in July 1982. In that report reference is made to four distinct time periods during which certain forces caused major changes in agriculture. It appears that we are now entering the fifth period, one of management power. If so, computers could become the most important technological development in American agriculture in the remainder of this century (see graph).

At this point in time, statewide computer networks exist in about one-fourth of the states. Most others have acquired some computer capability with linkages to some but not all counties in that state. Regional centers or institutes have been formed in order to encourage sharing of expertise and to plan future developments. Nationally, communications are now routinely transmitted between and among Extension Service-USDA and nearly all state Extension Services. Efforts are underway to refine and improve this system.

Extension Services face great problems in selecting and retaining state of the art computing equipment because of rapid changes within the industry. Three generations of equipment, each with greater capacity, have occurred in less than 10 years. Extension Services have been somewhat reluctant to choose among available hardware knowing that their choice might be outdated by the time it was installed. No federal funds were appropriated and states experienced difficulty in obtaining dollars required to adopt such technology at a time when state and/or county governments were financially strapped.

Ten years ago, hardware typically used an equipment specific operating system. Today's hardware can utilize a variety of operating systems. This makes it possible to share state developed software packages with other states and thereby realize some of the efficiencies of a national extension network. However, too little has been said about the continuing financial requirements to maintain statewide networks, linkages among states and with federal offices and development of useful software packages. States with networking capability can attest that more dollars are required annually to maintain a "state of the art" network, train existing staff and develop appropriate software than is required to purchase hardware. Progress in this regard will be less than desirable so long as such costs must be borne by inflation eroded budgets.

FORMULA REVISION

Federal funding for extension work in the states is authorized under the Smith-Lever Act. Funds are distributed to the states under Sections 3(b) and 3(c). Initial allotments to states in 1914 were subsequently increased by nine separate pieces of legislation before they were consolidated in the Smith-Lever Amendment of 1953. This was amended again in 1955 and 1962. The 1962 amendment now stands as the basic formula with additional programs being funded under a Section 3(d) provision with formulas appropriate to the program.

ECOP appointed a task force in October 1982 to review the formula under which funds are allocated to states. The Task Force submitted initial recommendations to ECOP in April 1983. The committee recommended guidelines, suggesting that any new formula should: 1) grandfather current 3(b) and 3(c) at current levels in order to minimize program distribution; 2) retain the current four (4) percent for federal administration and twenty (20) percent equally distributed to each state; 3) appropriately recognize total population and agriculture (broadly defined); and 4) provide earmarking of funds for innovative and multi-state efforts. ECOP accepted these guidelines as valid.

Twenty formula's were evaluated before arriving at final recommendations submitted to ECOP in August 1983. The recommendations that ECOP accepted in November 1983 were:

1. Existing 3(c) funds, excluding retirement and penalty mail funds, should be shifted to 3(b) and such funds allocated to the states henceforth at the level of formula funds received in 1985.
2. The Smith-Lever Act should be amended to expanded the 3(b) section to allow the Congress, at which time they may wish, to shift 3(d) funds to 3(b) with the allocation to each state henceforth equal to that received the year of the shift.

3. The Smith-Lever Act should be amended to distribute increases in formula funds, 3(c), after 1985 as follows:

   * 4% to ES-USDA for administration.

   The remainder to be distributed to the states as follows:

   * 5% to a state or groups of states for special projects.
   * 20% in equal portions.
   * 15% according to cash farm receipts.
   * 25% according to farm population.
   * 25% according to rural population.
   * 10% according to total population.

4. The data used to calculate distribution of 3(c) funds to states shall be updated at such time as new data are available for all factors. It is anticipated that this will continue to be approximately every ten years when new census data are released.

5. The factor used to represent cash farm receipts should be a rolling 10-year average of annual cash farm receipts for each state.

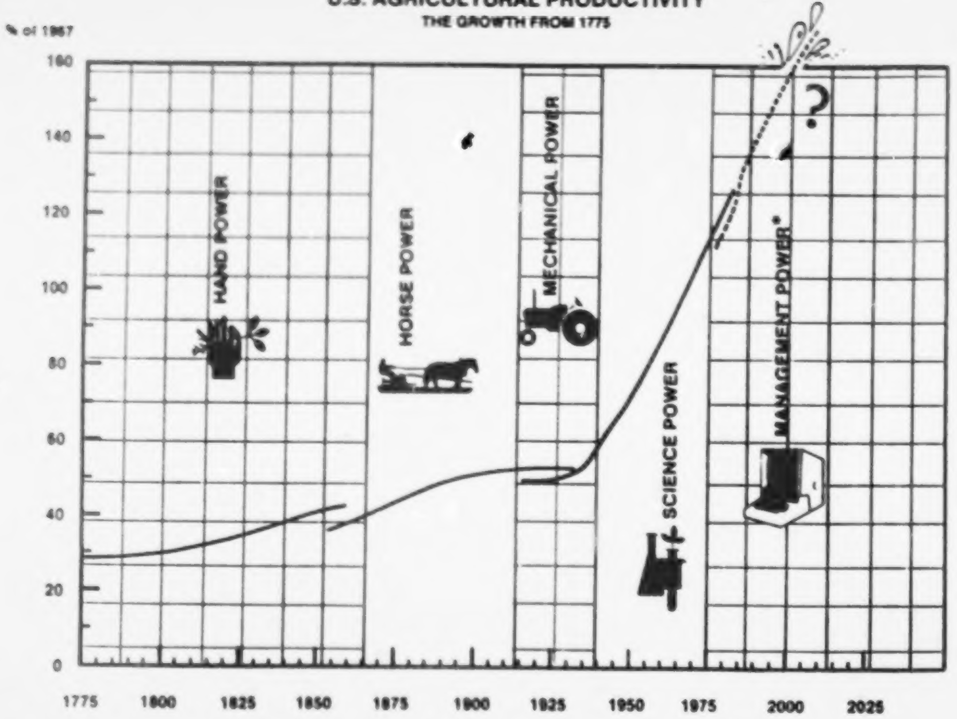
These final recommendations were circulated to all Extension Directors/Administrators with the request that the report be discussed by regional Director groups, and be discusssed further by the Extension Section, Division of Agriculture NASULGC during the annual meetings. A national meeting of all Extension Directors/Administrators was scheduled for February 1984 to complete discussion and determine a course of action. In order to facilitate action at the February 1984 meeting, chairmen of the regional Extension Director groups were asked to continue the formula discussion and if possible determine a concensus position of that group. In February 1984, the discussion continued, focusing heavily upon what formla best represents the intent of the legislation. Regional chairmen of Extension Director groups reported the concensus position of their respective groups. Their reports indicated that the Directors were about equally divided in their support of the existing formula vis a vis the recommended modification. They did support the change that would facilitate transfer of 3(d) funds to 3(b) as innovative programs mature. The concensus of ECOP was that there was not sufficient reason for us to press for a change in the formula at this time. Concensus among the states on such a change will be difficult to achieve until it is evident that 1) there is a change in legislative intent, 2) there is strong sentiment expressed by Congress and the Executive Branch that a change is in order. Should such events occur, I believe that Extension Directors would work together to develop a formula revision reflecting new guidelines that could then be discussed with Congress.

Mr. Chairman, it has been my pleasure to be here today. I have appreciated the thorough manner in which these hearings have been conducted and the assistance of your staff, particularly Mr. Skip Stiles. If there is any further way I can be helpful, I would be glad to do so.

(Attachment follows:)

U.S. AGRICULTURAL PRODUCTIVITY

THE GROWTH FROM 1775



*THE COMPUTER-MANAGEMENT POWER FOR MODERN AGRICULTURE
Extension Committee on Organization and Policy
July 1982

GRASSROOTS
GRASSROOTS AMERICA
1001 Jefferson Street, Suite 100
Wilmington, Delaware 19801
(302) 652-2414

GRASSROOTS - AN AGRIBUSINESS VIDEOTEX SERVICE

Testimony

To

U.S. House of Representatives

Committee on Agriculture

Subcommittee on Department Operations,

Research and Foreign Agriculture

Bruno Lepe
General Manager
June, 1984

Background

The computer and sophisticated management techniques are taking their place alongside the tractor and plow as tools of the farmer's trade. This process is dictated by the increasingly complex marketing, purchasing and operating decisions required as part of routine farm management. Difficult economic times have placed even greater pressure on the farmer to improve profitability and operational efficiency by obtaining the most timely information regarding market conditions, product prices, weather and other factors affecting his business. In this context, there are a number of specific areas where the farmer has immediate problems critical to his viability which can be addressed through videotex.

Similarly videotex is attractive to organizations selling goods and services to farmers. First, most of the personal contact with the farmer that existed in earlier years of farm retail sales has diminished. Companies can no longer afford to field large offices of detail men, maintaining constant and direct ties with the farmer. Thus, much of the feedback that fostered product improvement and more effective marketing has been lost. Second, these companies suffer when the farmer is uninformed about product benefits and pricing. An educated buyer is more profitable. Indeed, there is much criticism on the part of the farmer today directly as a result of the decrease of sources providing straight- forward, non-misleading information. Videotex represents a more cost effective communications and marketing tool.

The Service

Grassroots America is a joint venture of three major farm co-operatives - Agway Inc., CENEX and Southern States Co-operative Inc., and Videotex America. Videotex America is in turn a joint venture of The Times Mirror Company and Infomart, a videotex company who launched a similar service in Canada in 1981.

The Grassroots service, launched in January 1984, will be available to subscribers in Maryland, Delaware and Pennsylvania in mid-summer and will be expanded to other areas of the United States in 1985. It is the nations first full-color, two-way interactive videotex service for farmers. Based on the new NAPLPS (North American Presentation Level Protocal Syntax) videotex standard it allows farmers to access thousands of electronic ´pages´ of constantly updated news, weather, market and management information anytime of the day or night.

Grassroots provides not only instant access to information and markets but also offers interactive farm and financial management programs and electronic mail. It can also offer on-farm banking and shopping.

With the Grassroots service, farmers will have access to weather forecasts for a 50-mile radius around their farm in the form of full-color maps. They will have access to continuously updated futures markets with charts and graphs, local elevator prices, market analysis, research reports, government bulletins, equipment reviews, chemicals, seed, feed and more. This information will be found in one place, always up-to-date and available when a farmer wants it.

A unique feature of the Grassroots service is that a major portion of the cost of providing and maintaining the computerized farm management data base is borne by agribusinesses who sponsor programs, generate content and provide constantly updated information on their products and services. The net result is a competitively priced service for the farm user.

The subscription fee to farmers is $50/month including two hours of usage and $9/hour thereafter. The fee includes communications and excludes terminal costs. The terminals can be a simple converter attached to a subscribers television set or a personal computer with the appropriate software converter. Using the capabilities of the personal computer and its display screen, the only other hardware required is a modem to connect the system into the telephone network.

The costs to the information provider are for content creation, storage and updates. On the average, page creation is $180/page, the storage charge is $6/page per month and the update charge is $10/page. Information Providers may "sponsor" generic content such as the Chicago Board of Trade - sponsorship rates vary according to the number of times the sponsored application is used. Additional costs apply if the information provider wants to do market research (electronic questionnaires) or develop an interactive program such as a cost benefit analysis program.

Subscriber Benefits

The key benefits for farmers using Grassroots are:

- Single organized source of information
  - user gets technical information, market data analysis, product information, financial data along with educational and lifestyle material from a single source.
- Timeliness of information
  - information updated as new data becomes available; i.e., avoid the distribution delays.
- Direct communications with suppliers, government and others
  - through the messaging service user can communicate directly with the information service providers.
- Information available on request
  - farmer is no longer dependant on having to be in a particular place at a particular time. Farmer has access to latest information at his convenience.
- Low cost
  - the farmer has access to the services at a much lower cost than if he had to go out and purchase/source each individual piece of information.
- Ease of use
  - farmer needs no technical background. All services are provided for their understanding.
- Access to decision support tools
  - farm managment programs allow for individual analysis of operating procedures and alternatives.
- Time saving
  - save time on sourcing information and avoid unnecessary operations (e.g., spraying for insects when not required).
- Increased efficiency/decreased costs
  - buy/sell at the right time, keep abreast of newest and most cost efficient developments (e.g., chemical spraying).
- Increase market scope
  - farmer no longer limited to buying/selling at local level.

Information Provider Benefits

Some of the key benefits to the organizations providing information are:

- New Sales Approach

  Through interactive programs the information providers can sell their goods/services directly, thus reducing cost of sales.

- New Marketing Approach

  Information providers can get a direct reading on the effectiveness of their message. Grassroots information providers receive a monthly report on how many times each of their "pages" has been accessed. The medium is not time or space limited thus allowing the advertiser to tell the complete story. Their message can also include timely information as it can be updated as often as required. Through the use of interactive programs the advertiser can reinforce their messages; i.e., if low cost is the feature to sell an interactive cost comparison analyzer can be part of the application.

- Communications

  Through the messaging service the information provider can communicate on a one-on-one basis with their clients.

- Market Research

  By using electronic questionnaires the information providers greatly reduce their costs of doing market research as it eliminates the need to print the questionnaire, mail them out and code the results for analysis.

- Corporate Image

  Through their early involvement with the service the other advertisers gain a competitive edge while also establishing their image as a company in the forefront of change.

Grassroots and Extension

The key to the success of Grassroots is in its ability to meet the farmers' local, national and international information needs.

In recognition of the important role Extension can play in meeting this objective we have approached the Extension people in our initial launch site with the following proposal:

1. In order to become familiar with the Grassroots service and monitor its development we have offered them the use of a videotex terminal. Where applicable we are prepared to convert an IBM or compatible personal computer to Grassroots capability. The offer includes a free subscription and 5 hours of usage per month.
2. To ensure the continued cost effectiveness of Grassroots to farmers we have established an Agricultural Database Advisory Council (ADAC). This council meets quarterly and we have asked them to name one of their Extension agents to sit on the council. The council is also comprised of a cross section of university, agri-business and farmer representatives.
3. We believe Grassroots provides a good opportunity for Extension to disseminate its information such as research updates, news on agricultural developments, insect and disease bulletins. In recognition of Extension status we have made this offer waiving our standard schedule of charges.
4. In the course of launching Grassroots we are organizing several information seminars for farmers and have asked for the active participation of their agents.

To date the response has been extremely positive from all concerned.

It is our intention to get as much Extension involvement in the development of Grassroots as is possible. We believe that the relationship we are trying to establish benefits all concerned:

1. Grassroots America benefits from the agricultural expertise and undertstanding of the farming community of Extension and thus can provide a better service to the farmer.

2. Extension benefits from the computer technology expertise being developed by Grassroots America while being assured that it is working with ongoing business concern. Extension can concentrate on its strengths of agricultural development, research and consulting.

3. Through this approach it is possible to get commercial interests to sponsor the development of new agricultural farm management tools (e.g. software).

4. The farmers benefit by getting access to a cost beneficial farm management service which meets their need - the common objective of Grassroots America and Extension.

MARYLAND COOPERATIVE EXTENSION SERVICE
TELECOMMUNICATIONS SYSTEM

TESTIMONY PRESENTED TO

U.S. House of Representatives
Committee on Agriculture
Subcommittee on Department Operations
Research, and Foreign Agriculture

Dr. Ralph J. Adkins
Maryland Cooperative
Extension Service
College Park, MD 20742

May 12, 1984

EXTENSION SERVICE TELECOMMUNICATIONS SYSTEM

Much attention has been focused on the power of computers for decision-making assistance, recordkeeping and office management. Equally important to the Extension Service is the communication capability of the microcomputer.

Sources of information previously available only to grain brokers or the largest producers can now be made economically available to all agricultural producers. Time sensitive information can be distributed directly to users without the delay of further handling and mailing.

History and Development

Since 1982 the University of Maryland Cooperative Extension Service has been working to develop a microcomputer driven information system. Based on the Radio Shack videotex system, it has become known as ESTEL representing Extension Service Telecommunications System.

With the financial assistance of the Farm Credit Banks of Baltimore and the county Farm Bureaus in Somerset, Worcester and Wicomico counties, the state level unit and a county host unit was established. This initial configuration allowed information to be collected at the University of Maryland and sent by telephone to the county host unit in Princess Anne, Maryland. The information was then accessible 24 hours a day, seven days a week. Users in four counties could access the computer with a local phone call.

In 1983 a second host unit was established in Talbot County allowing three more counties to access the system with a local telephone call. Two of these county offices obtained microcomputers allowing them to load their own information in addition to the state database.

Hardware Configuration

The state-level unit consists of two Radio Shack TRS80 Model II microcomputers with auto dial modems. One computer is used simply as a word processor to create documents, while the second machine receives information from campus specialists, Agricultural Marketing Service and the National Weather Service automatically downloading to the two county units. The county units also consist of Radio Shack Model II microcomputers equipped with communication multiplexors and automatic answering phone modems. The multiplexor gives the unit the ability to answer up to eight phone calls simultaneously.

A second microcomputer is required to give the capability of inputting local information into the system. The one host unit with this capability daily updates local cash grain prices and the current insect and disease status. The second microcomputer is available for normal computing functions in the Extension office during the remainder of the day.

The initial users accessed the system using Radio Shack videotex terminals coupled to their telephone and television sets. These 8K terminals, costing about $400 were soon replaced with 16K terminals costing about $300. The next step was to access the system with Radio Shack microcomputers allowing disc storage and printing of the information. In 1983 a software revision allowed access by any microcomputer and at the same time made the system interactive.

Information Available

Information in the database is obtained from a number of different sources. The Agricultural Marketing Service provides both future prices from the Chicago Board of Trade and cash prices from livestock, fruit and vegetable terminal markets. Weather information supplied by the National Weather Service gives forecast information for each Maryland county as well as regular agricultural weather forecasts. Marine weather is updated three times a day with coastal, offshore and high seas forecasts covering the entire Eastern seaboard.

Information from the Extension specialists at the University of Maryland is added to the database daily. Such information includes Ag A.M. Morning News from USDA, Maryland Extension news, IPM weekly reports, variety trial reports, home economics information, and other similar Extension information.

The addition of local information is expected to increase rapidly as all county offices receive computers with this capability later this summer. At present local information includes local cash grain prices, insect conditions and calendar of events.

A complete listing of the June 1984 ESTEL menu follows.

ESTEL Menu For The Month of June 1984
SOMERSET BASED SYSTEM (543-2010)

Menu	Report Description	Menu	Report Description	Updated
	GENERAL INFORMATION			
MENU	Database Menu	MCES1	Extension News	
AGAM	Ag A.M. Morning News (500,501,502)	MCES2	Extension Calendar	
	MARKETING INFORMATION			
GRAIN FUTURES		LIVESTOCK AUCTIONS		
CBT1	Chicago 9:35am w/previous close(1501)	1600	Lancaster Livestock	Tu/Th
CBT2	Chicago 10:50am w/previous close(1502)	1601	New Holland (cattle; sheep)	Fri
CBT3	Chicago Settlement Close (1503)	1602	Vintage Livestock	Wed
		1603	Flash New Holland Hogs	Mon
		1604	New Holland Feeder Pigs	Thu
6852	Local Grain Basis (Seaford DE)	1605	New Holland Hogs	Mon
NEARBY TERMINAL MARKETS		1606	Lancaster Feeder Pigs	Wed
1212	New York	1607	Lancaster Hogs	Tue
1213	Philadelphi			
1214	Pittsburg	1608	Lancaster Feeder Cattle	Mon
FRUIT TERMINAL MARKETS		1620	Lancaster County Weekly Review	Fri
1220	Baltimore	1649	Weekly Feeder Sales	
1231	New York			
1233	Pittsburg	6800	Maryland Feeder Pig Summary	EOM
VEGETABLE TERMINAL MARKETS		6801	Felton, DE Livestock Summary	Thu
1239	Baltimore	MDA1	Weekly Broiler Summary (6802)	Wed
1250	New York	MDA2	Feed & Grain Report (6803)	Fri
1251	Phildelphia			
1252	Pittsburg	MDA3	Grain News (J. Crouthers) (6804)	Fri
		MDA4	Weekly Crop/Weather (6805)	Mon
	WEATHER INFORMATION			
7000	Menu of Weather Products	CMI	Crop Moisture Index (7013)	Tue
7001	Lower Eastern Shore	7014	National Agricultural Summary	Wed
7002	Upper Eastern Shore	7015	Foreign Agricultural Summary	Wed
7003	Cecil County	7016	Delmarva Agricultural Weather	Daily
7004	Lower Southern Maryland	7017	Piedmont Agricultural Weather	Daily
7005	South Central Maryland	7018	30 Day Outlook (current 30 day period)	
7006	East Central Maryland	7217	Climate Information..Chestertown	
7007	North Central Maryland	7218	Climate Information..Centerville	
7008	Allegany County	7220	Climate Information..Royal Oak	
7009	Garrett County	7223	Climate Information..Princess Anne	
7010	D.C. Area Forecast	7500	Marine Weather Products Menu (38 items)	
7012	5-Day Forecast for MD & DE			
AGRICULTURAL INFORMATION		FAMILY AND HOME INFORMATION		
2000	Agricultural Menu	3000	Menu	
2101	Custom Rates...Lower Shore	3001	Food News for May (Meat & Poultry)	
		3002	Food News for May (Fruits & Vegetables)	
		3003	Unemployment and Stress	
2499	Temperature Unit Accumulations	3010	Avoiding Mortgage Default	
IPM1	Alfalfa IPM Report	3020	Asbestos in the Home	
IPM2	Small Grain IPM Report	3030	Meat & Poultry Label Notes (USDA)	
IPM3	Corn IPM Report	3040	Weeks Best Buys	
2504	Vegetable IPM Report	3041	Receipt of the Week	
		3102	Free USDA Publications	

Network Structure

The ESTEL user works through his local or area Extension office. His personal contact is with the same Extension agent with whom he has traditionally worked. Many of the decisions about operations, financing and information services are made by local Extension advisory committees. The types of information provided and the target audiences can be tailored to the needs of the specific host sites.

Maryland Extension agents have not been by-passed but have been very much a part of the development and implementation of this system. With the capability of loading county information directly into the system database, immediate response to county needs can be achieved.

While the local information is important, the bulk of the database is collected by the Extension computer unit at the University of Maryland. We depend heavily on the standard daily reports of the USDA Agricultural Marketing Service, National Weather Service and the Maryland Department of Agriculture. This information and the work of our Extension specialists form the backbone of our database.

Target Users Group

The ESTEL system does not seem to attract the user who wishes to browse through frames of information. Instead, we have found that our users have very specific information needs that must be met before they are interested in other topics. Initially it was grain producers who supported the system for Chicago Board of Trade prices. Now, during the summer months, there is a strong group of users accessing only fresh market vegetable reports.

Weather information is an area of increasing interest, ranging from international reports to daily zone forecasts. Specialized products such as agricultural weather reports and marine weather forecasts appeal to specific audiences.

While the husbands may have purchased the unit for farm markets, their wives are accessing home economics information. As ESTEL reaches more urban areas, we expect a large home horticulture users group to emerge and more recreational boaters will use the marine information.

ESTEL System Costs

The state unit at the University of Maryland collects, stores and forwards information to county host units. The hardware cost for this state unit is about $10,000.

The county host units receive the state database, collect local information and offers the entire database to county users. With the capability to handle up to eight telephone lines, a county host unit costs about $14,000.

The user may subscribe to the system for $40 per year and utilizing his existing telephone service and television set can access the database with a terminal costing as little as $300. On the other hand, he may also access it with more advanced computer equipment, saving the data in memory or printing out hard copy.

These costs do not include telephone charges. Every effort has been made to locate host units where several counties can be served. In all instances users are able to access the system with a local phone call.

ESTEL User Survey

In March 1984 a telephone survey was made which identified some of the characteristics of both the system and its users: There are 41 paid subscribers with an estimated 100 users of the system.

-- ESTEL users farm from 50 to 2000 acres of land averaging about 450 acres. Most of the farms are grain operations in combination with either vegetables, broilers or livestock.

-- It was found that 59% are accessing the ESTEL system with videotex terminals while 41% are accessing with microcomputers.

-- The most popular time to access the system was from 4:00 PM to 6:00 PM. The next most popular time was from 12:00 noon to 1:00 P.M.

-- The length of time on line ranged from 1 to 30 minutes with the mean being 6.2 minutes.

-- Frequency of use showed 36% using the system once per day; 33% using it more than once per day; and 31% using it less than once per day but about 3 times per week.

-- The greatest usage was in the spring, summer and fall. Usage was more frequent whenever the farmers were marketing grain or livestock.

-- Seventy-seven percent of the subscribers operate the system themselves while the remainder indicate a spouse, family member or employee retrieve information.

-- Marketing information was by far the most used information in the system, while weather was the second most popular. Ag A.M. was the third choice, and pest management was the fourth choice.

-- Users enjoy the convenience of the system and the ability to access information at any time of the day.

Future Direction

Any system of electronic communication depends on two key components for success. One component is reliable hardware, while the other is up-to-date information. While attempting to provide both components, the Maryland ESTEL system has concentrated its efforts in developing or obtaining hardware and software that functions with reliability. We are satisfied now that our system can be operated and maintained while serving one-third of Maryland's counties.

The development of the information database and the expansion of the entire system has been limited by the computer hardware available to specialists and agents. In July we plan to install microcomputers in every county and in each Extension department with the capability of both accessing and contributing to the informational database. At the same time, we would like to install a market wire from the Ag Marketing Service that will give us easier access to the market reports.

A third host unit will be housed on the University of Maryland campus serving the two surrounding counties. Other host units will be installed in the remaining Maryland counties as the need develops and funds permit.

Whether ESTEL or a similar system, electronic information delivery is a viable and appropriate role for Extension. Computer technology is just another tool that Extension agents and specialists will have at their disposal to assist with the adoption of research findings of the land grant institutions.

(Attachment follows:)

Maryland Cooperative Extension Service
University of Maryland
College Park • Eastern Shore

EsTel

Extension Service Telecommunication System

A computer-managed information system for your home, farm or office, the **ESTEL** System combines your telephone and television through a simple remote terminal to provide access to nationwide sources of information.

A local phone call to your county Extension office allows you to select the information you want from USDA, Maryland Extension specialists and county Extension faculty.

The Maryland Cooperative Extension Service has adopted the videotex concept to significantly change Extension's method of dissemination of educational information. Joining two familiar household appliances, the telephone and the television, with an inexpensive videotex terminal make every home or office part of a large communications network. Almost anything published in books, magazines or newspapers can be stored and transmitted by a videotex system.

The Extension Service Telecommunication System **(ESTEL)** originates from a microcomputer located on the University of Maryland campus. This is the hub of a network that collects information from the U.S. Department of Agriculture, university specialists and other information sources. Automatically, several times daily this information will be transmitted by telephone to microcomputers in county Extension offices.

The information base will be stored and maintained in county Extension offices throughout the state. County Extension agents can also generate information about local concerns and input it directly into the system.

Connected to the county microcomputer is a multiplexer that allows the system to simultaneously answer up to 16 incoming phone calls. Twenty-four-hour-a-day service makes the system truly available at the user's convenience.

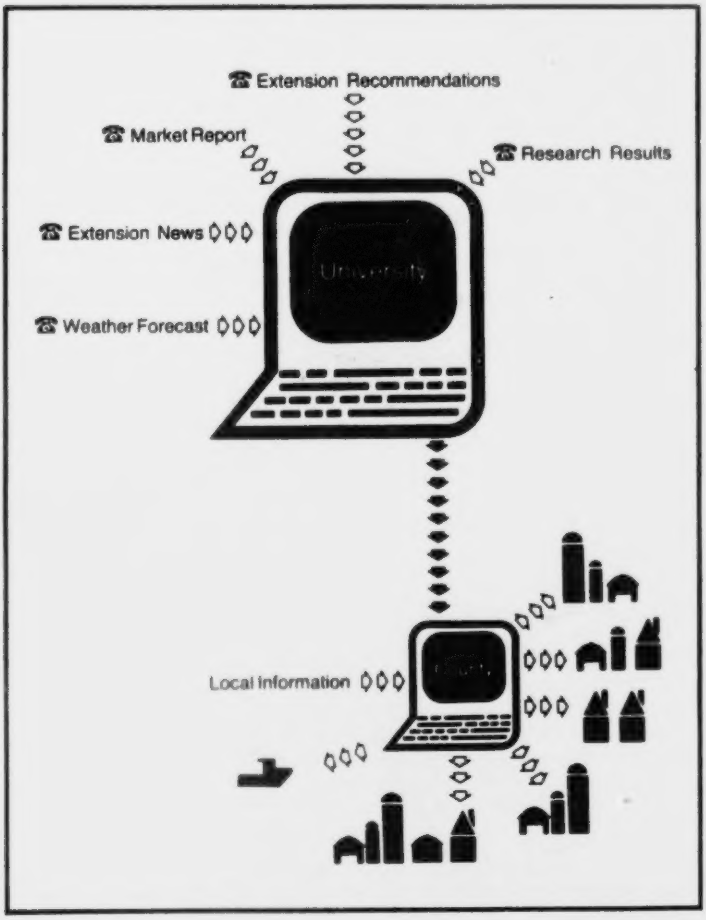
With information stored in the county microcomputer, Extension clientele can access it with the simplicity of a local phone call. Selecting the information needed, the client will type in the reference numbers on the keyboard of the videotex terminal and call the local **ESTEL** system. Within seconds the information requested will begin to appear on the home TV set. The information is stored in the videotex terminal for later retrieval and display on the television screen.

Designed to be flexible and dynamic, the **ESTEL** system allows the input of information from county as well as state and national sources. Information stored is directed to local interests and updated several times daily.

Information in the Maryland ESTEL system covers:

- Market reports
- Weather forecasts
- Agricultural recommendations
- 4-H information
- Energy conservation
- Home economics facts
- Extension Service news

For further information on **ESTEL**, contact the Maryland Cooperative Extension Service or your county Extension office.



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Presentation at the

HEARINGS ON AGRICULTURAL RESEARCH

SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND FOREIGN AGRICULTURE of the COMMITTEE ON AGRICULTURE, HOUSE OF REPRESENTATIVES

1302 Longworth House Office Building
12 June 1984, 1:30 p.m.

Theodore L. Hullar, Ph.D.
Director, Cornell University Agricultural Experiment Station, and
Director for Research, College of Agriculture and Life Sciences
Cornell University

My name is Theodore L. Hullar. I am Director of the Cornell University Agricultural Experiment Station and Director for Research for the New York State College of Agriculture and Life Sciences at Cornell University.

I provided testimony last year, on 28 June 1983, before this Subcommittee as a part of the earlier hearings on agricultural research. The present testimony builds on my last year's testimony.

My purpose in this presentation is to show that universities, and particularly our land grant universities, are the central part of our agricultural research system, and that a competitive research grants program for basic research for agriculture is essential if we are to receive full value from these universities.

To do this, I wish to present five major themes:

- Universities are the central part of our national agricultural research system.
- Basic research is the core of our universities.
- Competitive grant programs are essential for basic research for agriculture.
- Competitive grant programs for basic research for agriculture must have certain characteristics.
- More competitive grant programs are needed for effective basic research and graduate training in agriculture.

Universities are the Central Part of Our National Agricultural Research System.

Our national agricultural research system consists of three parts:

- Our universities, and especially our land grant universities with their associated state agricultural experiment stations
- Federal activities, such as the federal laboratories of the Agricultural Research Service of the U.S. Department of Agriculture (USDA) and of the National Institutes of Health (NIH), and federal extramural funding programs
- Industrial and private research laboratories

Of these three parts, the universities, and especially our land grant universities, have the central, seminal responsibilities for at least three reasons:

(1) Universities are places where research and scholarship are preeminent.

(2) Universities are responsible for education of the research scientists for our government and industrial laboratories and of the faculty for our universities and colleges. This responsibility is not shared by any other agency or institution. As such, this places special responsibilities on universities and government.

(3) Universities are the home and center for our cooperative extension programs, bringing the results of research to potential users.

To fulfill these three functions, universities must do a significant amount of basic research and must have sufficient resources to do this basic research. Because basic research knows no geographic boundaries and cannot be targeted at its inception to any practical application, primary support of basic research is truly a federal responsibility.

Basic Research is the Core of Our Universities.

It is in universities, and certainly in our land grant universities, where so much of the nation's basic research is done. Upwards of 50-60% of the research done in our state agricultural experiment stations is basic research.

Basic research fuels the development engine. It is basic research in our agricultural experiment station that infuses our applied and developmental research with new concepts and tough questions. It is basic research that provides the new knowledge that accelerates our technology development. And it will be basic research in our agricultural research sector that will permit us to build the multidisciplinary teams with scientists from outside agriculture to help solve the tough problems ahead.

Education of students is the unique responsibility of universities. To be effective, education requires research of all kinds, but particularly basic research. Basic research provides the principles for application. It permits a considered probing to elucidate abstruse phenomena.

But, basic research for agriculture is all too often slighted because of the enormous pressures for applied and developmental research to solve specific problems of crop and region. Furthermore, local and state governments, and even industry, are often reluctant to fund basic research where no practical pay-off is easily foreseen. As we have noted above, funding of basic research is legitimately the rightful responsibility of the federal government because such research is truly national in scope and effect.

Competitive Grant Programs are Essential for Basic Research for Agriculture.

One method for funding basic research is through the time-honored formula funding programs such as the Hatch and Regional Research Fund allocations, the McIntire-Stennis allocations, and the animal health allocations. This provides a stable funding base, particularly for long-term research. However, this base has not been increasing sufficient to cover the losses of buying power caused by inflation.

A second method for funding basic research is through competitive grants. The competitive grants programs of the National Science Foundation (NSF) have been particularly successful in supporting leading scientists, in advancing basic research in the biological and physical and social sciences, and in providing critical support for education of young scientists. The mission-oriented competitive grants programs of the NIH have been particularly successful in achieving the spectacular advances in bio-medicine. Both of these programs, for example, have laid the theoretical and experimental basis for the rapid advances and applications in biotechnology. Furthermore, these programs have been responsible for attracting top scientists in universities.

Competitive grant programs have similar advantage for agriculture, for at least two reasons:

(1) They have the potential for attracting and holding top scientists in agricultural research, where otherwise the scientists might well be working on other areas such as bio-medicine.

(2) Competitive grant programs can supplement the formula funds and provide much needed additional funding for agricultural research.

Thus, it is essential that the competitive grant programs for agriculture be increased very substantially. To do otherwise is to deny the opportunities for agriculture and to frustrate the commitment and interest of dedicated faculty and research scientists.

Characteristics of Competitive Grant Programs for Basic Research for Agriculture.

Certain general characteristics should apply to all competitive grant programs. For example:

(1) Competitive grant programs should be designed to obtain the maximum interest from all competent scientists, regardless of original discipline.

(2) The programs should be designed to elicit the most creative, innovative thinking and analysis.

(3) In addition, for mission-oriented competitive grants programs, such as those for the NIH or the USDA, they must be designed to address the fundamental questions of special interest for achieving the mission objectives, but--at the same time--not be inordinately subsumed to the immediate specific problems of the mission agency.

The following more-specific characteristics should apply to competitive grant programs for agriculture:

(4) The programs should aim at a basic biological and physical understanding and should not be segregated into plant, animal, and microbe classifications unless absolutely necessary.

(5) A broad array of grant programs should be available starting with the introductory pre-doctoral student and continuing through senior faculty fellowships to allow for retraining. (See below for further discussion.)

(6) Multidisciplinary studies should be encouraged.

(7) All funds should be allocated solely on a competitive basis, without regard for geographic distribution.

(8) All applications should be investigator-initiated and peer-reviewed, with all scientists in public and private universities, research institutes, and government laboratories eligible to apply.

(9) The programs should be complementary to existing funding programs in the USDA, NSF, NIH, and other agencies and should be designed to enhance interaction among the program areas and among scientists.

(10) To insure a mission-orientation (as necessary), a program council should be established, comprised of leading scientists with a broad view of basic research for agriculture.

(11) Competitive grants programs must be added to the existing research and education programs, such as formula funds, and must not be a replacement or redirection of current programs or funds.

A comprehensive program of grants and fellowships must be provided to attract scientists and faculty at all stages of their research careers. For example, it is essential to have a predoctoral fellowship program to attract the most promising graduate students into careers in agricultural research. The following outline presents funding programs that, ideally, should be part of a comprehensive competitive grants and fellowships program for USDA:

- Education
  - Pre-doctoral fellowships
  - Post-doctoral fellowships
  - Training grants (for establishing and nurturing strong graduate degree programs in new fields)

- Project support
  - Young investigator awards (for the most promising young faculty to help them get started in their first three years)
  - Research grants (for major project support)
    - Individual grants
    - Multidisciplinary grants
  - Research Career Development Awards (for the most accomplished and promising established investigators)

- Program support
  - Equipment (the impending crisis in obsolete equipment makes this imperative)
  - Research support (general support as an incentive award)

- Re-training
  - Senior post-doctoral fellowships
  - Senior faculty awards

All of these characteristics and types of awards were presented by the Committee on Biotechnology, Division of Agriculture, National Association of State Universities and Land Grant

Colleges (Progress Report II, November 1983) in the proposals for a national initiative on basic research in biotechnology for agriculture. In addition, each of these programs has been used at one time or another by federal agencies.

More Competitive Grant Programs are Needed.

The national biotechnology initiative (described in the Committee report) and incorporated into the Executive Budget proposals for FY 1985 incorporates the above principles and is an example of the type of programs that are needed.

The proposed biotechnology program has a projected budget of $70 million/year! This is four times the current USDA total competitive grants program! However, this amount is clearly justified and needed. The average level of funding proposed (e.g., $100,000/individual research grant) is comparable to a modest NIH grant and is just enough to fund a small project without being diverted unduly to get additional support. The program will fund only about one-third of the ca. 600 investigators presently working in biotechnology in the agricultural experiment stations. An equal number of interested and qualified scientists may be working outside agricultural experiment stations. In addition, it is estimated by the Committee that over 200 additional investigators will begin biotechnology studies by 1986-87. Thus, the proposed $70 million/year program is sufficient to fund only about 1/6-1/4 of eligible, competent scientists.

But the biotechnology program is only the first program that is needed. It deals only with information biology, the specific biology of molecular genetics and directly related disciplines. In addition, the following competitive grant programs for agriculture are also needed:

Organismal biology
The biology, chemistry, and physics of whole organisms by themselves or in their surroundings. Included here would be the basic studies related to disciplines such as animal and poultry sciences, agronomy and plant breeding, plant pathology and entomology, and the horticultural sciences.

Ecological biology
The biology, chemistry, and physics of larger systems. Included here would be the basic studies related to topics such as pest management, soils, weed science, agroecosystems, soil conservation, soil and water management, waste and energy management, and toxic and hazardous effects.

Nutrition and food sciences
The biology, chemistry, physics, and engineering related to the preparation and processing of our food, and the studies of nutrition.

Social and economic analysis

The social, economic, and institutional analysis that seeks to explain, correlate, and predict social, economic, and institutional effects of topics such as the effects and impacts of new technologies and the effect of external conditions on the broad agricultural and food sectors.

The programs proposed here should not eliminate the current programs in photosynthesis, nitrogen fixation, genetic improvement, stress, and human nutrition. Rather, the proposed programs are much broader and would place the current programs into a larger context.

The desired cost for the organismal and ecological programs would, together, be over $100 million/year. The nutrition and food sciences programs would be at least $35 million/year.

These are ambitious targets, but the need and opportunity is also great. Indeed, when it is recognized that only 1-2%, at most, of the gross value of agricultural products is spent on agricultural research, and when we note that the average annual return on agricultural research investment is 30-50%, it is clear that the nation is underinvesting in agricultural research.

It is now time to reverse this underinvestment. A major competitive grants program for basic research in agriculture would establish a new momentum, and signal a renewed commitment to the continued health of U.S. agriculture.

Thank you for your interest. We all look forward to your support.

Corrected Copy

STATEMENT

OF

JOHN P. H. BRAND
ASSOCIATE DEAN
COLLEGE OF AGRICULTURE AND NATURAL RESOURCES
THE UNIVERSITY OF CONNECTICUT
AND
CHAIRMAN
RESIDENT INSTRUCTION COMMITTEE
ON
ORGANIZATION AND POLICY
(RICOP)
DIVISION OF AGRICULTURE
NATIONAL ASSOCIATION OF STATE UNIVERSITIES
AND
LAND GRANT COLLEGES
(NASULGC)

BEFORE THE

SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH,
AND
FOREIGN AGRICULTURE
OF THE
COMMITTEE ON AGRICULTURE
HOUSE OF REPRESENTATIVES

HEARINGS ON AGRICULTURAL
RESEACH, EXTENSION AND
HIGHER EDUCATION

JUNE 12, 1984

ROOM 1302, LONGWORTH HOUSE OFFICE BUILDING

Testimony Before the Subcommittee on Department Operations, Research, and Foreign Agriculture of the Committee on Agriculture

Mr. Chairman and members of the Committee, I am John P. H. Brand, Associate Dean of the College of Agriculture and Natural Resources at the University of Connecticut, and current chairman of the Resident Instruction Committee on Organization and Policy (RICOP) of the Division of Agriculture, National Association of State Universities and Land Grant Colleges (NASULGC). I am pleased to accept your invitation to comment upon critical higher education issues facing the food and agricultural science and education system. The members of the Resident Instruction Section, join me in expressing appreciation to this Committee for including higher education in the scope of these oversight hearings. I welcome this opportunity to present testimony to complement that given on February 7, 1984.

The Joint Council on Food and Agricultural Sciences comprised of individuals from agricultural experiment stations, Cooperative Extension Service, Land-Grant and non-Land-Grant Universities, foundations, private industry, and USDA agencies in its report, "FY 1985 Priorities for Research, Extension and Higher Education--A Report to the Secretary of Agriculture," recommended eight national priorities from 24 which had been recognized. Scientific expertise development was ranked second in their recommendations. Basic biotechnology research was given the highest priority. It is, therefore, not unexpected that the higher education concerns of RICOP deal largely with issues associated with the development of food and agricultural scientists. The following list of issues was prepared by the Higher Education Programs unit of USDA's Science and Education and reflect RICOP's concerns regarding the academic community's capability to provide the nation's food and agricultural scientists, managers, and technical professionals.

ISSUES ASSOCIATED WITH THE DEVELOPMENT OF FOOD AND AGRICULTURAL SCIENTISTS

Scientific literacy of students entering U.S. colleges and universities has declined dramatically during the past decade. For the first time in our nation's history, high school graduates are less prepared in the fundamental sciences than were their parents at graduation.

Students entering a number of the food and agricultural sciences programs have shown between a 30 to 50 point decline in SAT verbal and mathematics scores while significant increases have been noted for students entering engineering programs.

Some 20 percent fewer individuals will constitute the traditional college-age population in 1991 as compared to today. Without attention, significantly fewer students will prepare for scientific, managerial, and technical careers in agriculture. Enrollments in land-grant colleges of agriculture already have declined by 20 percent during the past four years.

A shortage of college graduates with expertise in the food and agricultural sciences has been predicted through the decade. It is imperative that a continuing supply of high quality students be attracted to programs in our agricultural colleges since the future role and position of American agriculture will be heavily influenced by the human capital base.

On-going federally sponsored graduate fellowship programs in the physical and health sciences have been quite instrumental in attracting top scientific talent to these fields. As a result, food and agricultural sciences graduate programs have found it increasingly difficult to attract top quality students.

Of the approximately 1,000 doctoral degrees awarded annually in the U.S. in food and agricultural sciences specializations, some 38 percent are awarded to nonresident foreign aliens. Less than one percent of these foreign students remain in this country after graduation and are available to meet U.S. employment demand.

Unusually high numbers of agricultural scientists and educators who began their career shortly after World War II will retire during this decade. Replacements are simply unavailable in many food and agricultural specializations.

> Colleges of agriculture have experienced a serious deterioration of their capacity to educate highly qualified agricultural scientists and professionals. Inadequate investments for faculty, facilities, and equipment have seriously eroded program quality requisites for preparing students for highly technological positions in agriculture.

In an effort to address these issues, RICOP has strongly supported the Food and Agricultural Sciences National Needs Graduate Fellowships. We have recommended an appropriation of $10 million for FY 85. These fellowships represent a dedicated and committed program for increasing agricultural scientific and professional expertise in priority specializations. We continue to believe that these superior fellowships of $15,000 will give us a competitive edge in efforts to attract high-achieving students to recognized critical areas of need.

It is often argued that significant proportions of USDA funds, purported at times to be as high as 25 percent, provided through state agricultural experiment stations, give adequate redress to expertise shortages and negate the need for graduate fellowships. However, I believe the evidence fails to support this contention.

I have included in my testimony a copy of a table (Table 1) showing Assistantships/Fellowships (salary support) for graduate students in Agriculture and Natural Resources-Funds provided through State Agricultural Experiment Stations. The figures reveal that 3,729 graduate students are employed, in part, with USDA funds. However, fund support averages only .36 per FTE. These data are based upon a joint RICOP/ESCOP Graduate Student Survey, Fall 1983. USDA support for each graduate student is relatively low.

If a comparison is made of the dollars of federal support distributed through state agricultural experiment stations with the total fiscal year appropriations in each fund source, it is revealed that relatively small proportions of allocated USDA funds are directed to graduate student support. This is shown in the following table developed by the speaker.

PRELIMINARY REPORT

TABLE 1. Assistantships/Fellowships (salary support) for graduate students in Agriculture and Natural Resources[1]

PART I. Funds provided through State Agricultural Experiment Stations

Source of salary support	Number Employed	Teaching Assistants FTE's	Teaching Assistants Dollars	Research Assistants FTE's	Research Assistants Dollars	Extension Assistants FTE's	Extension Assistants Dollars	Other Graduate Personnel FTE's	Other Graduate Personnel Dollars
1.1 Federal Funds									
1.11 USDA									
1.111 Hatch	1697	3.3	$64,403	618.0	$8,026,700			5.9	$97,207
1.112 RRF	300	3.3	$71,303	196.8	$2,630,069			1.6	$21,073
1.113 McIntire-Stennis	378	2.9	$38,384	105.4	$1,396,639			1.1	$16,603
1.114 Animal Health (Sec. 1433)	66			9.6	$143,563			0.8	$11,043
1.115 CSRS Special Grants	134	0.7	$16,366	30.3	$646,366	2.5	$29,700		
1.116 Competitive Grants	88	2.0	$23,600	34.0	$323,300			0.6	$9,056
1.117 Contracts, Grants, Coop									
1.1171 ARS	129			47.9	$631,003			2.9	$28,885
1.1172 ERS	44			15.0	$174,305			1.0	$15,300
1.1173 FS	100			43.2	$606,740			0.3	$7,630
1.1174 Other USDA	533	11.6	$228,017	182.4	$2,662,363	3.5	$37,339	2.4	$34,612
1.12 Non-USDA	82			26.0	$339,386				
1.2 Non-Federal Funds									
1.21 State Appropriations	3309	63.3	$869,547	987.0	$14,689,200			10.2	$161,326
1.22 Sales and Related Income	137	1.7	$26,039	41.0	$606,206	0.3	$3,206	3.0	$41,116
1.23 Private Industry	726	0.2	$2,957	290.6	$3,367,302			4.3	$63,178
1.24 Foundations	202	0.1	$1,539	136.2	$873,693			1.3	$23,673
1.25 State Agency Grants	396	0.1	$1,565	101.2	$1,412,576	0.6	$5,371	1.2	$19,528
1.26 Others (Gifts, etc.)	323	2.3	$30,107	77.1	$1,082,063			0.1	$790
Totals	8604	92.1	$1,382,763	2986.9	$39,812,311	6.9	$76,036	37.3	$513,062

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[1] This data based upon RICOP/ESCOP Graduate Student Support Survey, Fall 1983.

Assistantships/Fellowships (salary support) from Federal funds provided through State Agricultural Experiment Stations for gradute students in Agriculture and Natural Resources as a percentage of FY 83 appropriations

Source of Federal Salary Support	Dollars of Support	FY 83 Appropriation	Federal Salary Suppo ÷ FY 83 Appropriation
Hatch	$8,188,398	$149,295,000	5.5%
RRF	2,723,945	107,000,000	2.5%
McIntire-Stennis	1,451,828	12,452,000	11.7%
Animal Health (Sec. 1433)	154,606	5,760,000	2.7%
CSRS Special Grants	690,388	27,775,000	2.5%
Competitive Grants	558,236	17,000,000	3.3%

Only an average of 4.3% of these appropriated funds are directed to graduate student support through agricultural experiment stations. It should be noted, however, that some USDA funds are distributed by research units other than state agricultural experiment stations for graduate Assistantships/-Fellowships (salary support). The amount, however, is relatively small. Unless a part of the research funds are dedicated specifically for graduate student support, there is no assurance that USDA funds, whether they be Hatch, RRF, McIntire-Stennis, etc., will be utilized to attract and support graduate students nor is there any assurance that the array of critical expertise shortage areas will be addressed. The justification for a continuing strong program of Food and Agricultural Sciences National Needs Graduate Fellowships remains clear and viable.

We believe continued appropriations are needed to enable this program to achieve its stated objectives. Assistant Secretary O. G. Bentley, in an article entitled, "Forces Reshaping Agricultural Research and Educational Institutions" published in Increasing Understanding of Public Problems and Policies-1983 by Farm Foundation, Oak Brook, IL, reported the following as an emerging trend affecting the future of agricultural sciences and education in the United States:

> Recognizing that agricultural mindpower is crucially important to the security and well-being of this country. Our colleagues must take aggressive leadership in recruiting qualified undergraduates and expanding graduate education. Opportunities for post-graduate education must be expanded and encouraged.

We believe the graduate fellowship program is responsive to this call for action.

Evidence continues to mount that serious shortages of food and agricultural graduates at all degree levels will indeed develop. RICOP has reported that baccalaureate enrollment in the fall 1983 semester dropped 6.4 percent from a year earlier. Continued reductions are expected.

Dr. Dwayne A. Suter, Associate Dean, Texas A&M University and coordinator of the Food and Agricultural Education Information System (FAEIS) supported by Higher Education Program Unit funds has recently issued a preliminary analysis of expected retirements of food and agricultural science faculty. These data represent over 75 percent of the 1862 land-grant institutions. Normal retirement rates would result in approximately 14 percent of the faculty retiring in a five-year period. The following are a few areas of specialization with unusually large percentages of faculty who will be eligible to retire during the next five years:

Specialization	Percent eligible for retirement
Animal Sciences, General	21.2
Animal Breeding, Genetics	26.7
Dairy Processing	28.0
Dairy Production	18.4
Poultry Science	18.1
Agronomy	17.5
Plant Breeding and Genetics	20.6
Turf Management	19.5
Soil Science	23.4
Forest Management	23.1
Extension Education	19.4
Water Resources	17.9
Climatology/Meteorology	30.4

The above normal rates of retirement are largely the result of the unusually large number of faculty hirings that occurred in the post-World War II years. These figures do not reflect vacancies which currently exist.

There is growing evidence that supports Dr. O. G. Bentley's trend prediction that society would increasingly recognize "that agricultural mindpower is crucially important to the security and well-being of this country." The program of the American Association for the Advancement of Science (AAAS) national meeting in New York City on May 29 included a symposium, "Shortages of Agricultural Scientists: Scenario for the Future." Panelists included Assistant Secretary O. G. Bentley who spoke on "Federal Responsibilities and Initiatives for Assuring Development of Agricultural Scientists;" Dean H. O. Kunkel, Texas A&M University who addressed the topic "Projected Needs for Agricultural Scientists;" and Mr. Roland M. Hendrickson, Vice President of Pfizer, Inc. and President of the firm's Agricultural Division, who presented a talk, "Agricultural Scientists for the 21st Century - An Industry Perspective." Dr. Lawrence L. Boger, President, Oklahoma State University was prepared to deliver a talk, "Capacity of U.S. Colleges and Universities to Prepare Agricultural Scientists for the Future," but was unable to attend because of flight complications.

I believe some of their quotes would be of interest to the Committee:

Assistant Secretary Bentley

> Clearly, the strength of U.S. science and education depends on the quality of the people drawn into scientific and technological leadership positions.
>
> "Without hesitation I would assign the highest priority to stimulating and nurturing technical talent"-- (Quoting the President's Science Advisor, George Keyworth)
>
> I am encouraged that we are recognizing -- perhaps once again -- that this skilled and educated human resource is the most crucial and valuable one we have.

The Department of Agriculture can act as a coordinator and catalyst in many of these actions. (Actions recommended by the Joint Council)

Congress has given the Department of Agriculture a major reponsibility in encouraging the development of human capital in the food and agricultural sciences. I assure you that we are very much aware of the importance of this exciting challenge.

The total number of Ph.D. graduates in the agricultural sciences during the 1980's and beyond will need to be increased to fill university faculty vacancies and to meet industry needs.

To develop the necessary agricultural expertise we must put forth a renewed effort to attract high school graduates to the agricultural sciences.

Dean H. O. Kunkel

We will not likely know with any degree of certainty the consequences of an inadequate supply of agricultural scientists or even whether the supply has been adequate or redundant in either numbers or quality. Research undone, by definition, is unmeasurable. So is unaccomplished entrepreneurial activity. We can measure achievement in both research and entrepreneurship. But we cannot really know if a particular line of research would have occurred or a new enterprise would have been built if more or better scientists had been educated for the agricultural scene. We are left with counting the vacancies in the jobs society has created.

Is agricultural science attracting the best students? Few winners of National Merit Scholarships select an agricultural science as their course of study. In fact, the National Merit Scholarship program lists farming and ranching as the only careers in agriculture.

There are some who believe augmented research funding will accomplish what is needed. Others believe that a more rapid route -- scholarships, fellowships, and the like -- is demanded. Some of both seems necessary and it would be unfortunate if the routes became competitive with each other for resources.

There is no indication that demand for agricultural scientists will be less in the decade ahead than it is today. As a result of near term retirements in the public sector laboratories -- the Land-Grant Universities and the USDA -- intensification of the demand will occur. Heightened competition for the better scientists will surely occur.

It falls largely to academia and the associated experiment stations to educate and produce young scientists and science "entrepreneurs" for agriculture. Most of the disciplines in the agricultural sciences do not have a system for postdoctorate training. (This in itself suggests that a surplus of agricultural scientists has not existed in the past.) It follows that the academic system must be central to response to further demands. I expect it will need considerable help from federal agencies and industry.

Mr. R. Hendrickson

The potential consequences of this shortage of agricultural scientists have also been made clear:

Less assurance that our plentiful, reasonably priced, dependable supply of wholesome foods will continue. A potentially serious blow to this country's balance of trade, where agriculture has been one of the very few bright spots. A blunted instrument of foreign policy. Even a possible threat to our national security if, for instance, O.P.E.C. should demand payment in wheat instead of dollars during the next energy crisis.

The question, of course, is what can we do to solve the problem, to attract and develop the agricultural scientists we will need in the coming decades?

By the twenty-first century -- indeed, by tomorrow if that were possible -- we will need more agriculturally oriented corporate board members and chief executives, more leaders in government with a basic agricultural education.

We can reach that goal in one of two ways: by broadening agricultural education to include more of the social and political sciences, thus preparing trained agriculturalists to move into general management and policy roles with industry and government... or by somehow developing a greater undaerstanding of, and sympathy for, agriculture in managers and policy makers coming from other fields.

The former, to my mind, is preferable.

It is unquestionably valuable to consider and discuss our needs at meetings like this. But it is also unquestionably true that little of value will actually happen without leadership and action.

And I would suggest that the action should be initiated by a high-level 'action committee' ... chaired by an eminent educator... composed of representatives from academia, government, industry and working agriculture..and charged with proposing specific goals, plans and responsibilities for achieving them, realistic timetables, estimated budgets and methods of funding. These proposals should then be presented to our agricultural institutions and industry for their commitment, participation and action.

It takes 16 years to educate a Bachelor of Science...2 to 4 years more for an advanced degree...and an apprenticeship of at least 10 to 15 years before we can expect significant contributions to American agricultural technology. Today's first grader won't reach peak productivity until the year 2015 at the earliest.

We must start now to attract and educate those young men and women upon whom we will all depend in the twenty-first century!

President L. Boger

The scientist resource base is also related to the decreasing enrollment of students at the undergraduate level. One must

> realize that there is a positive relationship between undergraduate enrollments, graduate enrollments, faculty quality and availability, the quality of programs, and finally, the future of the food and agricultural resource base itself.
>
> Competitive grants have been seriously lacking in the agricultural area relative to those grants that have been provided to private institutions in the areas of biology and medicine. Because of the lack of funding, facilities and equipment are lacking.
>
> Most agricultural schools are already hard pressed to meet current program demands with the budget crunches they are facing. Such schools are finding it increasingly difficult to find sufficient funds available to obtain the critical mass of faculty, equipment, and facilities to meet the ever-increasing need of high technology education.
>
> If we are imaginative in attempting to attract top students to agriculture, we must be equally imaginative in assuring quality programs for them.

The Committee has asked, "How should Title XIV be amended to encourage state or private matching of higher education grants?" We believe the extant language is sufficient to permit such matching. Section 1417 of the Food and Agriculture Act of 1981 provides for competitive and non-competitive grants which "shall be made without regard to matching funds." Thus, innovative proposals with matching funds from states or the private sector are not precluded. I will discuss this further in a moment.

RICOP would suggest the following Title XIV amendments:

Sec. 1402. Congress finds that -

> This Nation's agricultural system is increasingly dependent on high technology. To maintain and improve productivity levels, manage the resource base, provide high quality products, and protect the environment requires a constant supply of food and agricultural scientific expertise.

This wording, extracted from the January 1984, Joint Council on Food and Agricultural Sciences publication, "Summary: Needs Assessment for the Food and Agricultural Sciences - A Report to the Congress from the Secretary of Agriculture," would give added emphasis to the Joint Council's recognition of the vital need for assured supplies of human capital.

Sec. 1402 (8) New Federal initiatives are needed in the areas of -

> (P) teaching programs involving state-of-the-art approaches to curriculum innovations such as a systems approach to problem solving, information systems via computer applications and ethics in the food and agricultural sciences
>
> (Q) food and agricultural expertise needs through faculty development in our nation's universities.

Sec. 1402 (10) National support of cooperative research, extension, and teaching efforts must be reaffirmed and expanded at this time to meet major needs and challenges in the following areas:

> (H) SCIENTIFIC EXPERTISE DEVELOPMENT. - America's food and agricultural system is seriously threatened by impending shortages of highly qualified scientists, managers, and technical professionals. Insufficient numbers of highly capable students are entering advanced degree programs in basic agricultural science disciplines and technical specialties to meet the nation's needs for food and agricultural scientific expertise. Scientific expertise shortages in the

> food and agricultural sciences impact on all regions of the Nation. Currently there are severe shortages of scientific expertise in such areas as biotechnology, food sciences, human nutrition, animal health and reproduction, soil and water sciences, international marketing and agricultural engineering.

Sec. 1417 (a) (3)

> Such grants shall be made without regard to matching funds [provided by the recipients.], but each recipient institution shall have a significant ongoing commitment to the food and agricultural sciences generally and to the specific subject area for which the grant is to be used.

The Committee has also asked, "What more can USDA do even without special appropriations to disseminate the results of curricula and faculty development efforts?" USDA's Higher Education Programs unit has funded a number of pilot projects with funds provided by the Agricultural Research Service which has a vital interest in assuring a supply of well educated and trained scientists. These projects include the following, all of which have supported the development of food and agricultural expertise:

Publication for High School Science Teachers

This initiative involves co-sponsorship of a project by the Council for Agricultural Science and Technology (CAST) to enhance high school science teachers' understanding of agricultural research missions. Periodic publications, directed to high school science teachers, focus on selected agricultural science topics such as water quality, food safety, and plant molecular genetics. Articles also include a discussion of agricultural science career opportunities related to the selected topic so that teachers may better advise their students.

Student Recruitment Strategies

This project is directed toward two broad areas. It seeks to enhance the image of agricultural careers among graduates from urban and suburban high schools and to increase the enrollment of these students, as well as traditional agriculture students from high school vocational agriculture programs.

Computerized Food and Agricultural Education Information System (FAEIS)

Cooperators have expressed a priority need for a national information system documenting the various attributes of food and agricultural higher education programs. The greatest needs are for comprehensive national data which will provide a detailed characterization of such attributes as faculty, student enrollment, degrees granted, student support, employment demand for graduates, etc. The Higher Education Programs Office is working cooperatively with Texas A&M University to develop such a system which will be user friendly, menu driven, capable of providing national and regional profiles, and which will also possess interactive query capabilities.

Faculty Development Initiative

A task force composed of government, industry, and academia representatives has been established and charged with developing a national food and agricultural sciences faculty development policy and agenda. The task force will define appropriate roles of the three cooperators--government, industry and academia, as well as identify opportunities for faculty development. The group will further endeavor to design programs and/or establish mechanisms to implement the action plan.

A National Network to Attract and Develop Excellent Scientists for Agriculture

If we are to have a highly efficient food system in the early 21st century, more high quality students must prepare for scientific careers in priority food and agricultural disciplines. An aggressive national program must focus attention on key scientific careers in food and agriculture. Major scientific and educational entities in the U.S. food production and delivery system must collectively challenge our nation's outstanding high school science students. Recognizing the foregoing, the U.S. Department of Agriculture has recently entered into a cooperative agreement with Purdue University to provide national coordination for this effort. Public and private sector leaders in the food and agricultural sciences will establish a national program to accomplish the following:

> Provide professional assistance to high school teachers in helping them emphasize science in agriculture;
>
> Conduct regional and national "Focus on Science in Agriculture" symposia involving agricultural scientists, outstanding high school students and teachers, and agricultural faculty;

Provide special incentives to outstanding high school students who have demonstrated excellence in the food and agricultural sciences;

Disseminate high quality materials which focus attention upon priority future careers in the food and agricultural sciences; and

Enhance mechanisms for placing outstanding high school science students with private and public sector agricultural scientists and their research programs.

Agriculture and Natural Resources Undergraduate Curricula Assessment and Development

In 1982, university and industry cooperators identified curriculum development as a priority concern for strengthening higher education in the food and agricultural sciences. Subsequently, a national curriculum assessment was undertaken which resulted in several areas being identified as priority areas for strengthening agriculture and natural resources curriculum

These priority areas include Agricultural Systems Analysis, Problem Solving, Ethical and Public Policy Aspects of Domestic and International Agricultural Systems, and Leadership. Efforts are currently underway to initiate development of curriculum materials in these areas and to encourage their adoption and use by colleges of agriculture across the Nation.

This last project initially developed from a $40,000 grant awarded under the authority of Sec. 1417(a)(2). Additional funds were then provided by the Exxon Foundation and the R.J. Reynolds Tobacco Co. We are now, with the encouragement of the Pfizer Corporation mounting a campaign to attract another $2 million dollars from agribusiness industry and foundations.

These funds will be used to develop course materials, conduct faculty training sessions, and to evaluate the effectiveness of the materials developed. A six-week training session for faculty is planned for each of the identified course areas.

Workshops, conferences, training sessions, and publications are some of the methods that will be used to disseminate the results of the various projects. In some projects, funds have been designated for this purpose; in others state, private, or foundation support will be secured to develop an optimal method of dissemination. In many instances established forums such as the NASULGC meetings or RICOP Summer Work Conferences will be used for the educational process.

It should be noted that we would not likely be at this stage of development in interest, awareness, and commitment to resolve the human expertise shortage unless the original Higher Education Programs Unit grant had been awarded. These seminal projects promise a significant return on investment. However, academia, industry, the states, Congress and USDA must recognize that federal support under Section 1417 will be necessary to develop comprehensive strengthening programs that will address the needs for faculty development, curricula improvement, student recruitment, and equipment and facilities improvement.

The emerging national problem of obsolete teaching laboratories and equipment was strikingly noted in Dean Charles E. Hess' (University of California, Davis) testimony before the House Committee on Science and Technology, May 8, 1984.

> There is little question that there are challenges. A 1980 AAU report to the National Science Foundation indicated that capital expenditures for instrumentation doubled in the five-year period from 1975 to 1979. Even with the increased expenditure, the median age of instrumentation at universities was twice that of industrial laboratories. My first-hand experience with this equipment problem is in connection with the expansion of our research and teaching programs in biotechnology. To recruit and adequately accommodate one scientist in this area of research costs an average of $125,000 for equipment alone. This figure does not include the cost of renovation of laboratories, which ranges from $30,000 to $60,000. Equipment is critical not only to attract and retain scientists of the highest caliber, but is equally important in the training of undergraduate and graduate students. In the area of biotechnology, the differential in the median age of equipment is undoubtedly even greater. The influx of venture capital into the new biotechnology firms has enabled these firms to set up state-of-the-art facilities. It is vital that our students have training and the opportunity to conduct research with equipment of at least equal quality if they are going to be effective in the private sector.

In response to this need and at the bequest of the Joint Council's Higher Education Committee, RICOP is developing a task force in cooperation with the American Association of State Colleges of Agriculture and Renewable Resources (AASCARR) and representatives of other food and agricultural organizations to develop supporting evidence for Congressional support of strengthening grants. This report will parallel the Human Capital Shortages: A Threat to American Agriculture brochure that generated support for the graduate fellowship program.

> In order to meet the food and fiber needs of the U.S. and the world now and in future decades, we require well-educated and trained people to provide and disseminate new knowledge and technology.
>
> Our world and our social and ecological systems are changing. And so must educational systems. If they do not change, their product--the students--will not be prepared to assume the roles for which they were educated and in which they are needed.
>
> The United States cannot continue as the lead nation in resolving food production and distribution problems associated with an expanding global population unless support for higher education in the agricultural sciences is strengthened.

Congress has designated the USDA as the lead agency in the Federal Government for the food and agricultural sciences and emphasized teaching as a direct mission of the Department. The Department must provide leadership to bear upon the threat of human capital shortages. Certainly this leadership must be shared by academia and industry. However, the Department can, through its influence, serve as a coordinator and catalyst to bring about awareness, understanding, and action. The Secretary's Challenge Forum was an excellent example of this kind of activity.

The pilot projects of the Higher Education Program Unit are other examples of activities that have brought together academicians, government leaders, and businessmen in a common cause - the improvement of higher education in the food and agricultural sciences. Much is yet to be done. I would recognize that two professionals and one secretary have comprised the staff of the Higher Education Programs Unit and are largely responsible for the progress made in the various projects previously outlined above. Yet certain projects, such as FAEIS, are only now beginning to bear fruit. We would hope that the Department will recognize the need to continue to support the further development of this project and others generated to enhance the nation's food and agricultural science teaching programs. We cannot presume the availability of sufficient numbers of highly trained and talented scientists, managers, and technical professionals unless we provide support and incentives to bring about that result. RICOP is prepared to work cooperatively with other members of the agricultural community toward this goal.

STATEMENT OF

DWAYNE A. SUTER

ASSOCIATE DEAN OF COLLEGE OF AGRICULTURE

TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS

Thank you, Chairman Brown, and members of the Department Operations, Research, and Foreign Agriculture Subcommittee for inviting me to participate in these hearings. I wish to address certain specific higher education issues highlighted in the draft charter. In particular, I wish to discuss (1) the need for the development of a comprehensive Food and Agriculture Education Information System (FAEIS) and (2) potential cooperation between Land-Grant institutions and private firms in the development and distribution of computer software appropriate for the agricultural sciences.

FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM

Introduction

The U.S. Department of Agriculture (USDA) is the designated lead agency of the Federal Government for agricultural research, extension, and teaching in the food and agricultural sciences. This responsibility entails assessing the extent to which the Nation's higher education system is producing the specific types of graduates required to meet the needs for scientific and professional expertise in the food and agricultural sciences. A concomitant responsibility is that of strengthening the quality of college and university academic programs, faculty, and students in the food and agricultural sciences. The food and agricultural sciences, as defined by Congress in The Food and Agriculture Act of 1977 (P.L. 95-113) and as reaffirmed in The Agriculture and Food Act of 1981 (P.L. 97-98), include those academic programs concerned with the production, processing, marketing, distribution, conservation, consumption, research, and development of food and agriculture and natural resources, forestry, veterinary medicine, and home economics.

One of the ways whereby the Office of Higher Education Programs of the USDA is endeavoring to assist higher education institutions in strengthening their academic programs in the food and agricultural sciences is through the development of a comprehensive national information system which will provide ready access to empirical data essential to improved program planning, coordination, administration, and evaluation. The information system being developed will be known as the Food and Agricultural Education Information System (FAEIS). It will include such data as current and projected student enrollments, degrees conferred, teaching programs, attributes of faculty, graduate student support, and employment demand for graduates. Participation in FAEIS by the various disciplines (agriculture and natural resources, forestry, veterinary medicine, and home economics) is entirely voluntary. Furthermore, each discipline may elect to participate only in selected segments of the system.

Need for FAEIS

An adequate supply of university and college graduates with requisite expertise is basic to advances in American agriculture. The broad spectrum of the food and agricultural labor force has been relatively adequate in the past, but as indicated in a recent Science and Education, USDA study, serious shortages currently exist and are projected to increase through the eighties in many important areas. Additionally, leading university administrators and educators increasingly express concern about diminishing investments in higher education in the food and agricultural sciences and the adverse impact this is having on the quality of instructional programs and teaching faculty.

Assessment of the validity and significance of such claims and identification of solutions can only be made on the basis of sound national information documenting the current and evolving status of higher education in the food and agricultureal sciences and of employment of food/agricultural specialists. Recognizing the critical need for this type of information, the USDA, Office of Higher Education undertook an in-depth review of the numerous national data bases maintained by public or private agencies[1] which contain information relevant to higher education in the food and agricultural sciences. The findings of this review serve to substantiate the following conclusions:

1. While there are notable data bases and information systems which have been developed explicitly for assessing the Nation's scientific manpower in such fields as engineering, medicine, the physical sciences, and mathematical sciences, no comprehensive information system exists specific to scientific/professional expertise in the food and agricultural sciences and the various attributes of the academic programs which produce such expertise.

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[1] National Science Foundation, National Center for Education Statistics, National Academy of Sciences, Bureau of Labor Statistics, National Association of State University and Land-Grant Colleges, Council of Graduate Schools of the U.S., etc. (See EXHIBIT I-2, APPENDIX)

2. Existing data bases which include some information on food and agriculture lack needed specificity, are frequently incompatible for comparative purposes (e.g., labor force employment, placement of graduates), often lack contemporaneity by the time they are accessible to the public domain, and are scattered among diverse agencies making information retrieval by USDA and its cooperators time consuming, complex, and expensive.
3. Several types of important data are not collected as a part of current on-going system (e.g., college and university faculty, any costs of student education, sources and amount of student support).

FAEIS will attempt to address the problems identified in the study by selecting relating subsets of data pertinent to the food and agricultural sciences from national data bases maintained historically by other agencies such as the Department of Education, the Department of Labor, and the National Science Foundation. When necessary and when feasible, FAEIS will provide for refinements to these data and for analyses and interpretation by prefessionals with sophisticated expertise in the food and agricultural sciences. FAEIS will also provide for the acquisition of data, not presently being collected by any private or public agency, but which are deemed critically important in order to develop a present and evolving profile on higher education in the food and agricultural sciences.

With regard to data to be collected, representatives of both Land-Grant and non-Land-Grant institutions have asserted that the greatest need is for comprehensive national data which will help to identify current and projected problems associated with hiring and retaining highly qualified teaching faculty in the various disciplines. Such data are essential to planning for faculty development and/or redirection, as well as to projecting emerging faculty shortages. This information would also provide essential management tools for other science and education public administrators, public policymakers, and administrators of university programs. It would provide necessary guidelines for optimal allocation of human and financial resources, and would help to establish priorities for future personnel requirements.

Hence, it has become readily apparent that a critical need exists for a dynamic, comprehensive system which will provide empirical information for effective planning and coordinating efforts directed toward supporting and strengthening higher education in the food and agricultural sciences. It is important to note that the data proposed for inclusion in FAEIS represents a very broad spectrum of attributes of the U.S. higher education system in the food and agricultural sciences and of students and graduates of such programs. This breadth is essential if FAEIS is to serve both public and private representatives of the food and agricultural higher education system in the aggregate.

Joint Planning for the Design and Implementation of FAEIS

A nine (9) member panel of consultants from professional and scientific associations and university administrators in the food and agricultural sciences are working cooperatively with representatives of the USDA Office of Higher Education Programs to design and develop FAEIS. Liaison representatives for agriculture and natural resources, forestry, veterinary medicine, and home economics are providing guidance to the USDA Higher Education Programs staff with regard to:

*assessing user information needs

*identifying data sources

*evaluating the quality of data currently available

*identifying and prioritizing data that need to be collected in the future

*advice on sampling size and scheduling of data collection

*designing formats for the release of data via publications, summary statistical tables, and interactive query by computer

*recommending control measures to assure maximum integrity, confidentiality and security of the data

General Design of FAEIS

FAEIS will be a computerized information system with interactive capability. It will be user oriented with regard to content and ease of access. It will utilize existing data bases to the fullest extent possible, thereby requiring minimal acquisition of new data. By centralizing the information, FAEIS will allow for centralized information retrieval with obvious advantages over fragmented data availability. In addition, FAEIS will be a dynamic system amenable to revision or expansion as conditions and information needs change.

The archiving (storage) of data will be accomplished using a main frame computer in the USDA and in one of the participating universities. Right to privacy provisions will be strictly maintained and user access will be controlled by very stringent measures.

FAEIS will produce a regularly scheduled series of standardized statistical tables and reports for subscribers. A sample prepared for Home Economics is given in the Appendix. It will also have interactive query capability. Summaries will be reformated in different

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configurations based on the needs of users. For some categories of information, a user will be able to access historical and current data as well as projections for the future at the national, state, and regional levels.

The flowchart on page 8 documents procedures relative to the design and development of FAEIS. In interpreting the flowchart it is important to note that boxes drawn with solid lines represent procedures already executed. Boxes drawn with broken lines denote procedures currently in process or yet to be carried out.

The panel of consultants representing Land-Grant and non-Land-Grant member institutions representing agriculture, forestry, home economics and veterinary medicine has recommended the priority development of the following data bases:

1. Faculty Data Base--This data base concerns teaching, research, and campus-based cooperative extension faculty in agriculture and natural resources, forestry, home economics, and veterinary medicine.

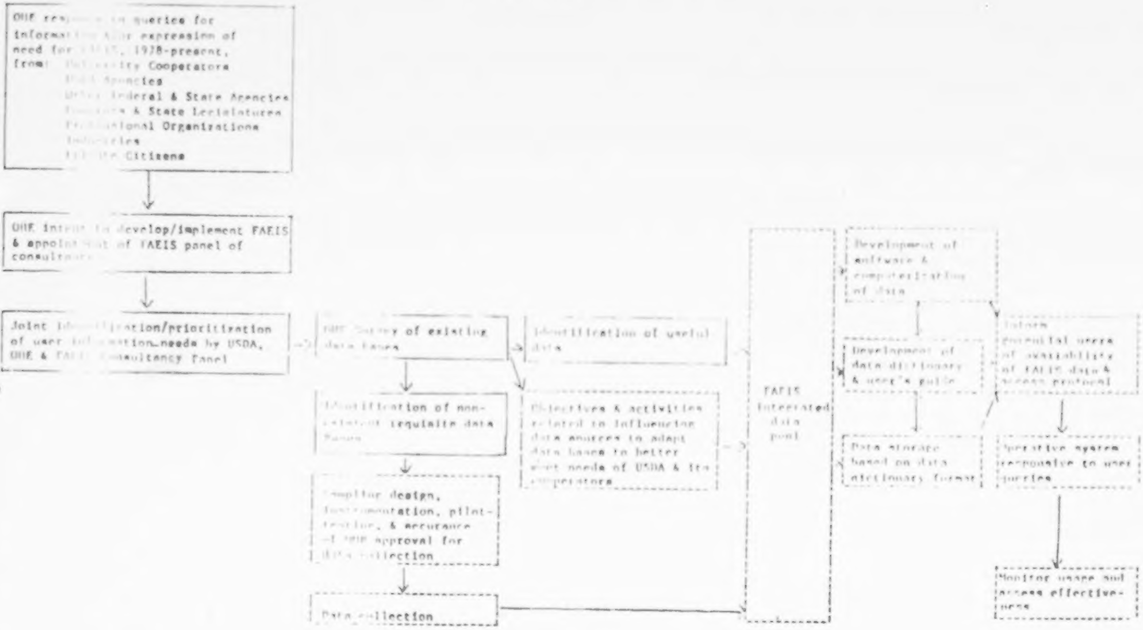
2. Student Data Base--This data base concerns enrollment and degrees conferred data for baccalaureate and higher level students in agriculture and natural resources, forestry, home economics, and veterinary medicine. This data base also includes student academic and socioeconomic data.

3. Employment Demand for Graduates Data Base--This data base concerns employment demand for food and agricultural graduates. Included in this base are current and projected average annual job openings.

4. Fiscal Data Base--This data base concerns budgets related to food and agricultural higher education. As well, the data base would include information on physical facilities at colleges and universities.

5. Teaching Program Data Base--This data base concerns teaching programs within the food and agricultural sciences in colleges and universities.

FAEIS DEVELOPMENT


OHE responses to queries for information &/or expression of need for FAEIS, 1978-present, from: University Cooperators
USDA Agencies
Other Federal & State Agencies
Congress & State Legislatures
Professional Organizations
Industries
Private Citizens
OHE intent to develop/implement FAEIS & appointment of FAEIS panel of consultants
Joint identification/prioritization of user information needs by USDA, OHE & FAEIS Consultancy Panel
OHE Survey of existing data bases
Identification of useful data
Identification of non-existent requisite data bases
Objectives & activities related to influencing data sources to adapt data bases to better meet needs of USDA & its cooperators
Sampling design, instrumentation, pilot-testing, & assurance of OMB approval for data collection
Data collection
FAEIS integrated data pool
Development of software & computerization of data
Development of data dictionary & user's guide
Data storage based on data dictionary format
Inform potential users of availability of FAEIS data & access protocol
Operative system responsive to user queries
Monitor usage and assess effectiveness

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Users of FAEIS

FAEIS will include a very broad and timely spectrum of data denoting attributes of the U.S. higher education system in the food and agricultural sciences and the employment demand for graduates in these fields. As such, it is intended to serve the information needs of education program planners and administrators, State and Federal representatives concerned with public policy and resource allocation, career counselors, employers, researchers, students, and private citizens.

Potential Impact of FAEIS

It is recognized that the food and agricultural sciences are frequently characterized by an inaccurate stereotyped public image. Incomplete and fragmented data descriptive of higher education in the food and agricultural sciences stand to contribute to the perpetuation of this image. FAEIS will provide more accurate, timely, comprehensive data which will be readily available to users striving to better understand/analyze these academic programs. Hence, it will enhance the ability of professionals to document program breadth, identify shortages of resources, justify requests for additional resources, and substantiate the Nation's need for graduates of higher education in the food and agricultural sciences.

Issues Yet To Be Resolved

At this stage of development, several issues remain unresolved which warrant future in-depth consideration by the FAEIS consultancy panel, the Office of Higher Education, and USDA specialists in information systems design and management. Such issues include the following:

1. Scheduling of data acquisition and analysis both with regard to data to be extracted from information systems maintained by other Federal agencies and data collected from original sources explicitly for FAEIS.
2. Integration of existing data bases available from other Federal agencies with new data bases developed specifically for FAEIS.
3. Selection of software for handling data bases.
4. Problems related to providing effective interface between various computer systems and hardware.
5. Identify most effective methods for users to access FAEIS data and for USDA to store and maintain data files.
6. Personnel requirements and a departmental plan for managing FAEIS, including establishment of policies for charging users for certain services.
7. Cost estimations and budget allocations for implementation and management of FAEIS, including necessary training conferences for users of FAEIS.
8. Establishment of a realistic schedule for final design and full implementation of FAEIS.

Budgetary Issues

The USDA (ARS) has provided thus far in contract funds to Texas A&M University $145,000 to begin the design and implementation of FAEIS. Preliminary design of FAEIS and various projects have thus far been completed.

A profile analysis of academic programs in agriculture and forestry offered in Land-Grant and non-Land-Grant universities in the

U.S. has been completed and a report issued. Student enrollment, degrees conferred, and student placement data are now being gathered and reported annually for member institutions from both the National Association of State Universities and Land Grant Colleges (NASULGC) and the American Association of State Colleges of Agriculture and Renewable Resources (AASCARR).

An OMB approved Faculty Survey instrument was mailed to U.S. Land Grant and non-Land Grant Colleges of Agriculture, Schools of Forestry and Colleges of Home Economics. A response rate in excess of 75 percent has been received from the 1862 Land-Grant Colleges of Agriculture and from the Schools of Forestry. Preliminary analyses of the data indicates that an unusually large percentage of the faculty will be eligible to retire during the next five years. The percentage eligible for retirement in the next five years ranges from 17.5-30.4 percent. The availability of a comprehensive information system in the food and agricultural sciences which would permit the identification of potential future expertise shortages based on supply/demand data is, therefore, critically needed for educators and users of the higher education system.

A jointly sponsored ESCOP and RICOP Graduate Student Support Survey Form was distributed to State Agricultural Experiment Stations and Land-Grant Colleges of Agriculture. Data has been received from over 82 percent of the institutions and agencies included in the survey. Data from additional institutions and agencies are expected.

Because of the comprehensive scope of FAEIS and the limited resources, it will be necessary to proceed with implementation on a sequential basis. The rate of development and implementation of FAEIS will be greatly dependent of the level of funding. At the current funding rate of approximately $75,000 per year, considerable progress has been made. A much higher funding rate will be necessary to significantly accelerate the development and implementation of FAEIS.

Computer Software Development and Distribution

The competitive edge of American agriculture has, in part, been due to the innovations and entrepreneurship of the participants. Whereas emphasis has previously been placed on maximizing production, the future is likely to be characterized by maximizing profits in economically good years and minimizing losses in the bad years. Therefore, the emphasis should be focused on management and decision making.

Developments in microcomputer technology will represent one of the major innovations affecting American agriculture in the '80's. The microcomputer coupled with quality software, should become an essential tool to assist the manager in the decision making process, whether the decision environment is in production agriculture or in agribusiness. However, the development of quality computer software for use in agriculture and the natural resources will not be inexpensive or easy due to the complex nature of the environment in which the decision maker must operate.

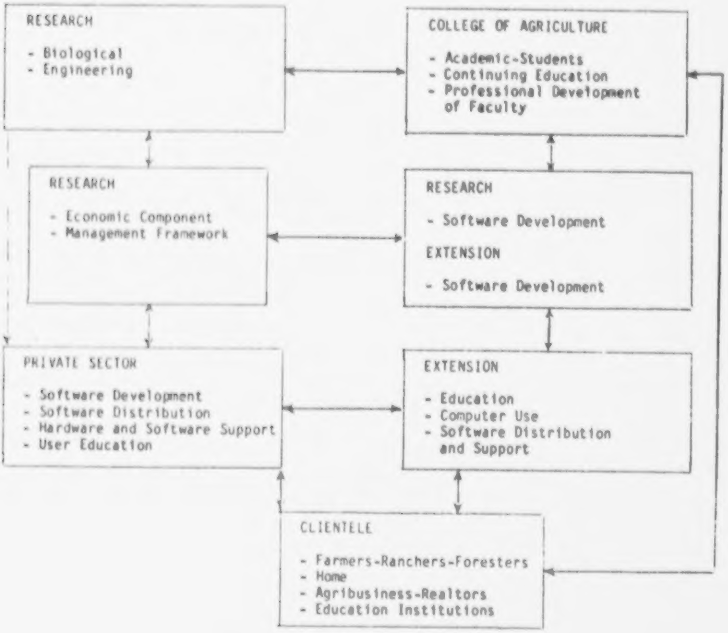
The development of quality microcomputer software for farmers, ranchers and foresters should follow a series of stages of development to include (1) problem definition, (2) review of currently available software, (3) review of appropriate research findings, (4) program design and development of appropriate program specifications, (5) program coding according to specifications, (6) program documentation (including user manual of instructions), and (7) program review, verification, field testing, and revisions.

The development process to produce quality software requires input from subject matter specialists (animal scientists, agronomists, agricultural engineers, agricultural economists, etc.), computer programmers, education specialists, farmers, ranchers and other potential users of the software.

The development process is both time consuming and expensive. The Land-Grant institutions represent a unique environment where program development and testing can occur. Collaborative agreements between private industry and the Land-Grant university can be mutually beneficial. Funds from private industsry can provide critically needed resources to be a complement to those provided by the institution.

The Land-Grant institution provides a valuable environment for the development and field testing of the software if teaching, research, and extension personnel can be involved with the outside end users, the farmers, ranchers, foresters and agribusiness firms. The interface of teaching, research, extension and the private sector in computer software development and distribution is illustrated in Figure 1. Licensing agreements between the institution and the private sector for

Figure 1. Interface of Teaching, Research, Extension and the Private Sector in Computer Software Development and Distribution


RESEARCH
- Biological
- Engineering
COLLEGE OF AGRICULTURE
- Academic-Students
- Continuing Education
- Professional Development of Faculty
RESEARCH
- Economic Component
- Management Framework
RESEARCH
- Software Development
EXTENSION
- Software Development
PRIVATE SECTOR
- Software Development
- Software Distribution
- Hardware and Software Support
- User Education
EXTENSION
- Education
- Computer Use
- Software Distribution and Support
CLIENTELE
- Farmers-Ranchers-Foresters
- Home
- Agribusiness-Realtors
- Education Institutions

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the distribution of the software should be economically rewarding for both concerned. The institution should be primarily concerned with investment recovery and that private industry be able to receive a return on its investment and a reasonable profit.

Institutions, however, will need to consider the monetary and professional rewards of the faculty and staff participants. Issues such as sharing of software copyright profits (if any), and how participation in the software development effort will be viewed by institutional administrators for promotion, tenure and salary increases must be resolved before accelerated faculty and staff involvement can be realistically expected.

These and other issues require early attention. The farmer and rancher clientele of the Land-Grant institutions are becoming more vocal with respect to meeting their needs for quality microcomputer software. They see their children moving into the computer age in elementary school and are anxious to do likewise in their operations.

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
I. Faculty Data Base	A. Faculty Survey	USDA, Office of Higher Education	No data presently available
	B. Higher Education General Information Survey - Salaries, Tenure, and Fringe Benefits of Full-Time Instructional Faculty	National Center for Education Statistics, USDED	No data available specific to academic teaching fields
	C. Survey of Scientific and Engineering Personnel Employed at Universities and Colleges	National Science Foundation	No data available pertaining to home economics scientists Limited amount of specificity regarding agricultural scientists

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
II. Student Data Base	A. Higher Education General Information Survey--Fall Enrollment and Compliance Report	National Center for Education Statistics, USDED	
	B. Higher Education General Information Survey--Degrees and Other Formal Awards Conferred	National Center for Education Statistics, USDED	Switch in taxonomy used for data
	C. Doctorate Records File: Survey of Earned Doctorates Awarded in the United States	Commission on Human Resources, National Resource Council National Academy of Sciences, National Science Foundation, USDED, National Institues of Health, National Endowment for the Humanities	Limited to only doctorate degrees Limited degree specialty list pertaining to food and agricultural sciences
	D. National Survey of Doctorate Recipients	National Science Foundation	Limited sample size Limited degree and employment specialties list

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
II. Student Data Base (continued)	E. National Longitudinal Study of the High School Class of 1982	National Center for Education Statistics, USDED	Food and Agricultural workers part of an aggregate group
	F. Survey of Graduate Science Student Support and Post Doctorates (Graduate and Post Doctoral)		Limited list of science fields
	G. Faculty Survey	USDA, Office of Higher Education	No data presently available

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
III. Employment Demand for Graduate's Data Base	A. National Survey of Recent Science and Engineering Graduates	National Science Foundation and USDOE	Limited sample pertaining to food and agricultural graduates Limited degree and employment specialty list pertaining to food and agricultural graduates
	B. The National Survey of Experienced Scientists and Engineers	National Science Foundation	Narrow definition of scientist Limited list of academic fields of study, occupations, and job activities pertaining to food and agricultural sciences
	C. Federally Employed Scientists and Engineers	National Science Foundation	
	D. Survey of Scientific and Technical Personnel in Private Industry	National Science Foundation and Bureau of Labor Statistics, USDOL	

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
III. **Employment Demand for Graduate's Data Base** (continued)	4. Current Population Survey	Bureau of Labor Statistics, USDOL	Limited sample pertaining to food and agricultural occupations
	5. Occupational Employment Statistics Census-Based Industry/Occupation Matrix (supplemented by data from Cooperative Extension Service, American Vocational Association, Department of Defense, Department of Education, Office of Personnel Management)	Bureau of Labor Statistics, USDOL	
	6. Occupational Employment Statistics Survey	Bureau of Labor Statistics, USDOL	Void of survey data for agricultural industries and self-employed workers Limited occupational detail

FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
IV. Fiscal Data Base	A. Higher Education General Information Survey-Institutional Characteristics of Colleges and Universities	Natiohal Center for Education Statistics, USDED	
	B. Higher Education General Information Survey-Financial Statistics of Institutes of Higher Education	National Center for Education Statistics, USDED	
	C. Agricultural Research Facilities Study	Joint council on Food and Agricultural Sciencies, Science and Education Admin, USDA	No data available at the college/departmental level for various academic disciplines
	D. Inventory of Physical Facilities at Colleges and Universities	National Center for Education Statistics, USDED	No data available at the college/departmental level for various academic disciplines
	E. 1979-80 Student Charges at State and Land-Grant Universities	National Association of State Universities and Land-Grant Colleges	

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
IV. Fiscal Data Base (continued)	F. Cost and Benefits of Graduate Education--Estimation of Graduate Degree Program Costs	The Council of Graduate Schools in the U.S.	No data available on costs of graduate education in the Food and Agricultural Sciences
	G. Fiscal Data Survey	Office of Higher Education, USDA	

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FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM PROPOSED DATA BASES AND ASSOCIATED DATA FILES

TYPE OF DATA BASE	SPECIFIC DATA FILE	SOURCE	LIMITATIONS
[illegible]. Teaching Program Data Base	A Teaching Program Survey	Office of Higher Education, USDA	

PRELIMINARY REPORT

- HOME ECONOMICS BACCALAUREATE AND HIGHER DEGREES CONFERRED IN THE UNITED STATES, 1982-83.
- HOME ECONOMICS TEACHING FACULTY IN 1890 SCHOOLS AND STATE UNIVERSITY MEMBERS OF NASULGC, FALL, 1983

Data Are Being Incorporated Into The FOOD AND AGRICULTURAL EDUCATION INFORMATION SYSTEM (FAEIS)

Higher Education Programs
Agricultural Research Service
U.S. Department of Agriculture
June, 1984

Table 1 Home economics baccalaureate and higher degrees conferred in the United States, 1980/81 (1)

Discipline Category	Degree level			
	Baccalaureate Degrees	Master's Degrees	Doctoral Degrees	Total Degrees
Home economics, general	590	84	7	681
Business home economics (2)	296	12	0	308
Clothing and textiles	4,719	168	13	4,900
Consumer economics and home management	1,058	116	25	1,199
Family relations and child development	4,775	933	133	5,841
Foods and nutrition	5,921	1,731	235	7,887
Home economics communication (2)	96	2	0	98
Home economics education (2)	3,787	555	32	3,374
Human environment and shelter	1,380	38	0	1,418
Institution, hotel, restaurant management	773	84	0	857
Total degrees conferred	22,395	3,723	445	26,563

(1) Based on HEGIS data from the National Center for Education Statistics, Department of Education (DOED)

(2) Data obtained from the American Home Economics Association

Table 2. Comparison of home economics teaching faculty at 1862 schools and state university members of NASULGC and of doctoral degrees conferred nationwide in home economics 1,2/

Teaching specialization	Employed FTE's		Unfilled FTE's				Projected changes in FTE'S thru 1988	Doctoral degrees conferred 1980/81
			Full-time		Part-time			
	Full-time	Part-time	Funded	Unfunded	Funded	Unfunded		
Home Economics, General	16.72	6.82	7.96	0.00	1.15	0.00	14.14	7
Home economics (general)	13.84	6.43	7.86	0.00	1.15	0.00	14.14	
International/comparative home economics	2.88	0.39	0.10	0.00	0.00	0.00	0.00	
Business Home Economics	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0
Business home economics	0.55	0.00	0.00	0.00	0.00	0.00	0.00	
Clothing and Textiles	185.33	53.19	21.10	0.00	0.33	0.00	35.37	33
Textiles and clothing (general)	65.10	25.65	7.64	0.00	0.00	0.00	15.38	
Apparel design	40.72	9.79	6.50	0.00	0.00	0.00	2.08	
Retailing/merchandising	36.90	9.05	5.30	0.00	0.33	0.00	11.71	
Textile science	42.61	8.70	1.66	0.00	0.00	0.00	6.20	
Consumer Economics and Home Management	79.74	22.77	12.00	0.00	0.25	0.00	9.59	25
Family/consumer resource management (general)	31.99	8.33	6.17	0.00	0.25	0.00	3.66	
Consumer science	18.75	5.84	2.80	0.00	0.00	0.00	2.93	
Family economics	29.00	8.60	2.83	0.00	0.00	0.00	3.00	
Family Relations and Child Development	372.66	107.76	28.63	0.90	1.70	0.50	39.80	133
Family and community services (general)	22.55	7.79	1.00	0.00	0.00	0.00	2.25	
Individual and family development (general)	47.73	31.00	3.58	0.00	0.00	0.00	7.41	
Adult development	20.14	3.41	2.07	0.00	0.00	0.00	5.72	
Family and marital counseling	27.96	4.83	2.25	0.00	0.00	0.00	4.00	
Family relations	72.64	15.52	7.58	0.90	1.33	0.50	7.26	
Gerontological services	19.86	0.25	0.75	0.00	0.00	0.00	2.17	
Child development	88.71	17.05	4.45	0.00	0.12	0.00	7.99	
Early childhood education	73.07	27.91	6.95	0.00	0.25	0.00	3.00	

See footnotes at end of table

Table 2. Comparison of home economics teaching faculty at 1862 schools and state university members of NASULGC and of doctoral degrees conferred nationwide in home economics[1,2]

Teaching specialization	Employed FTE's		Unfilled FTE's				Projected changes in FTE'S thru 1988	Doctoral degrees conferred 1980/81
			Full-time		Part-time			
	Full-time	Part-time	Funded	Unfunded	Funded	Unfunded		
Foods and Nutrition	267.56	67.66	34.76	1.07	2.10	0.00	29.32	215
Foods and human nutrition (general)	69.29	34.40	7.05	0.01	0.67	0.00	11.50	
Food science	42.87	14.70	4.93	0.25	0.05	0.00	3.80	
Dietetics	65.08	8.64	11.89	0.31	0.00	0.00	4.14	
Human nutrition science/research	62.20	6.06	5.52	0.00	0.00	0.00	6.92	
Human nutritional services	28.12	3.06	5.37	0.50	0.58	0.00	2.96	
Home Economics Communication	2.15	2.31	0.50	0.00	0.00	0.00	0.70	0
Home economics communications (general)	2.15	2.31	0.50	0.00	0.00	0.00	0.70	
Home Economics Education	158.25	11.43	5.01	0.00	0.00	0.00	9.87	32[3]
Home economics education (general)	152.62	10.50	3.75	0.00	0.00	0.00	9.64	
Non-formal extension education	5.63	0.93	1.26	0.00	0.00	0.00	0.23	
Human Environment and Housing	179.41	39.73	24.56	0.10	1.58	0.00	9.94	0
Interior design	79.70	20.95	15.70	0.00	1.33	0.00	5.05	
Human environment and housing (general)	18.21	3.18	3.75	0.10	0.00	0.00	3.06	
Household equipment	12.07	2.09	1.11	0.00	0.00	0.00	-0.67	
Housing	51.17	6.73	3.16	0.00	0.25	0.00	2.00	
Related arts, crafts	18.26	6.78	0.84	0.00	0.00	0.00	0.50	

See footnotes at end of table

Table 2. Comparison of home economics teaching faculty at 1862 schools and state university members of NASULGC and of doctoral degrees conferred nationwide in home economics 1,2/

Teaching specialization	Employed FTE's Full-time	Employed FTE's Part-time	Unfilled FTE's Full-time Funded	Unfilled FTE's Full-time Unfunded	Unfilled FTE's Part-time Funded	Unfilled FTE's Part-time Unfunded	Projected changes in FTE'S thru 1988	Doctoral degrees conferred 1980/81
Institution, Hotel, Restaurant Management	71.13	16.98	8.25	0.31	0.83	0.43	21.00	0
Institution, hotel, restaurant management (general)	21.15	4.12	2.00	0.00	0.83	0.43	9.00	
Executive houskeeping	1.00	0.25	0.00	0.00	0.00	0.00	1.00	
Food service systems management	38.85	11.74	4.25	0.31	0.00	0.00	8.50	
Hotel, motel, tourism, hospitality management	10.13	0.87	2.00	0.00	0.00	0.00	2.50	
Total	1333.50	328.65	144.77	2.28	7.94	0.93	169.71	445

1/ Faculty data are reported by the "Classification of Institutional Programs" (CIPs) adopted in 1982/83 by the National Center for Education Statistics, DOED. This table summarizes responses received by April 10, 1984 to the USDA, fall, 1983 Survey of College and University Faculty in the Food and Agricultural Sciences. The 30 1862 institutions reporting data represent a 63% response rate; the 20 state universities reporting data repesent a 57% response rate. The combined data therefore represent an overall 60% response rate for 1862 and state universities with home economics programs.

2/ Based on 1980/81 degrees conferred data reported by the HEGIS taxonomy used by the NCES, DOED prior to the adoption of CIPs. Future years data reported by the DOED will be classified by CIPs.

3/ Based on 1980/81 data reported by the American Home Economics Association.

Table 3. Frequency distribution of age of home economics teaching faculty at 1862 schools and state university members of NASULGC[1/]

Teaching Specialization Category	Total No	Total FTE	Under 30 No	Under 30 FTE	30-39 No	30-39 FTE	40-49 No	40-49 FTE	50-54 No	50-54 FTE	55-59 No	55-59 FTE	60 & Over No	60 & Over FTE
Home Economics, General	32	19.7	0	0.0	10	8.6	9	4.8	1	1.0	4	1.7	8	3.6
Business Home Economics	1	0.6	0	0.0	1	0.3	0	0.3	0	0.0	0	0.0	0	0.0
Clothing and Textiles	253	203.3	7	5.1	71	54.8	76	61.8	27	22.0	22	18.0	50	41.6
Consumer Economics and Home Management	113	82.5	5	3.9	40	29.4	38	28.9	7	4.8	14	10.0	9	5.3
Family Relations and Child Development	487	389.0	13	10.0	179	147.0	157	122.0	33	25.2	38	32.3	67	52.6
Foods and Nutrition	412	287.8	17	10.8	129	90.0	134	92.8	39	26.7	44	32.84	49	34.7
Home Economics Communications	3	2.0	0	0	1	0.6	2	0.9	0	0.2	0	0.3	0	0.1
Home Economics Education	107	85.1	1	1	28	19.9	37	30.2	15	11.0	16	13.7	10	9.4
Human Environment and Housing	193	160.0	8	5.3	73	58.1	57	51.7	24	18.3	14	12.3	17	14.4
Institution, Hotel, Restaurant Management	95	74.0	4	3.1	46	36.2	30	22.6	7	6.3	2	2.0	6	3.8
Total	1696	1304.0	55	39.1	578	444.9	540	415.9	153	115.5	154	123.2	216	165.4

1/ This table summarizes responses received by April 10, 1984 to the USDA, fall, 1983 Survey of College and University Faculty in the Food and Agricultural Sciences. The 30 1862 institutions reporting data represent a 61% response rate; the 20 state universities reporting data represent a 57% response rate. The combined data represent a 60% response rate of 1862 and state universities with home economics programs.

Table 4. Percent distribution of age of home economics teaching faculty at 1862 schools and state university members of NASULGC [1/]

Teaching Specialization Category	Total No(f)	Total FTE(f)	Under 30 No(%)	Under 30 FTE(%)	30-39 No(%)	30-39 FTE(%)	40-49 No(%)	40-49 FTE(%)	50-54 No(%)	50-54 FTE(%)	55-59 No(%)	55-59 FTE(%)	60 & Over No(%)	60 & Over FTE(%)
Home Economics/General	32	19.7	0	0	31	44	28	24	3	5	13	9	25	18
Business Home Economics	1	0.6	0	0	100	45	0	55	0	0	0	0	0	0
Clothing and Textiles	253	203.3	3	2	28	27	30	30	11	13	9	9	20	20
Consumer Economics and Home Management	113	82.5	4	5	36	36	34	35	6	6	12	12	8	6
Family Relations and Child Development	487	389.0	3	3	37	38	32	31	7	7	8	8	14	14
Foods and Nutrition	412	287.8	4	4	31	31	32	32	9	9	11	11	12	12
Home Economics Communications	3	2.0	0	0	33	29	67	44	0	10	0	15	0	2
Home Economics Education	107	85.1	1	1	26	23	35	36	14	13	15	16	9	11
Human Environment and Housing	193	160.0	4	3	38	36	30	32	12	11	7	8	9	9
Institution, Hotel, Restaurant Management	95	74.0	4	4	48	49	32	30	7	9	2	3	6	5
Total Percent	1696	1304.0	3	3	34	34	32	32	9	9	9	9	11	11

[1/] This table summarizes responses received by April 10, 1984 to the USDA, fall, 1983 Survey of College and University Faculty in the Food and Agricultural Sciences. The 30 1862 institutions reporting data represent a 61% response rate; the 20 state universities reporting data represent a 57% response rate. The combined data represent a 60% response rate of 1862 and state universities with home economics programs.

Table 5. Degree level and average monthly salary of home economics teaching faculty at 1862 schools and state university members of NASULGC, fall 1983[1/]

Faculty Degree Level	Average monthly salary per person and per FTE							
	Full-time employment				Part-time employment			
	Number	Salary	FTE	Salary	Number	Salary	FTE	Salary
Baccalaureate	34	1584	24.4	1828	414	509	169.7	563
Percent	3		2		52		51	
Master's	429	2218	388.4	2238	335	700	142.2	817
Percent	31		34		42		43	
Doctorate	913	2890	733.7	2882	44	1422	19.6	1516
Percent	66		64		6		6	
Total	1376		1146.5		793		331.5	

[1/] This table summarises responses received by April 10, 1984 to the USDA, fall, 1983 Survey of College and University Faculty in the Food and Agricultural Sciences. The 30 1862 institutions reporting data represent a 63% response rate; the 20 state universities reporting data represent a 57% response rate. The combined data represent a 60% response rate of 1862 and state universities with home economics programs.

1862 Institutions and state members of NASULGC included in Tables 2,3,4 and 5

1.	001009	Auburn University	1862
2.	001051	University of Alabama	NLG
3.	001081	Arizona State University	NLG
4.	001431	University of Delaware	1862
5.	001489	Florida State University	NLG
6.	001610	University of Hawii	1862
7.	001626	University of Idaho	1862
8.	001775	University of Illinois	1862
9.	001825	Purdue University	1862
10.	001869	Iowa State University	1862
11.	001892	University of Iowa	NLG
12.	002010	Louisiana State University	1862
13.	002103	University of Maryland	1862
14.	002290	Michigan State University	1862
15.	002329	Wayne State University	NLG
16.	002423	Mississippi State University	1862
17.	002516	University of Missouri	1862
18.	002532	Montana State University	1862
19.	002536	University of Montana	NLG
20.	002565	University of Nebraska	1862
21.	002568	University of Nevada-Reno	1862
22.	002657	New Mexico State UNiversity	1862
23.	002687	CUNY Brooklyn College	NLG
24.	002689	CUNY Hunter College	NLG
25.	002690	CUNY Queens College	NLG
26.	002842	SUNY College at Buffalo	NLG
27.	002906	Appalachian State University	NLG
28.	002923	East Carolina University	NLG
29.	003005	University of North Dakota	NLG
30.	003051	Kent State UNiversity	NLG
31.	003100	Ohio University	NLG
32.	003210	Oregon State University	1862
33.	003414	University of Rhode Island	1862
34.	003530	University of Tennessee	1862
35.	003644	Texas Tech University	NLG
36.	003658	University of Texas - Austin	NLG
37.	003675	University of Utah	NLG
38.	003696	University of Vermont	1862
39.	003754	VPI	1862
40.	003800	Washington State UNiversity	1862
41.	003895	University of Wisconsin	1862
42.	003915	University of Wisc - Stout	NLG
43.	003924	University of Wisc - St. Pt.	NLG
44.	003969	University of Minnesota	1862
45.	006883	Ohio State University	1862
46.	006964	Rutgers University	1862
47.	006965	Pennsylvania State Univ	1862
48.	007108	University of Puerto Rico	1862
49.	009265	North Dakota State	1862
50.	011693	Cornell University	1862

1862 Institutions and state members of NASULGC not included in Tables 2,3,4 and 5

1	001083	University of Arizona	1862
2	001108	University of Arkansas	1862
3	001312	University of California at Berkeley	1862
4	001313	University of California at Davis	1862
5	001350	Colorado State University	1862
6	001598	University of Georgia	1862
7	001758	Southern Illinois University	NLG
8	001809	Indiana University	NLG
9	001928	Kansas State University	1862
10	002053	University of Maine	1862
11	002221	University of Massachusett	1862
12	002440	University of Mississippi	NLG
13	002589	University of New Hampshire	1862
14	002590	University of New Hampshire Keene State	NLG
15	002950	N. Carolina Central University	NLG
16	002981	Western Carolina University	NLG
17	003170	Oklahoma State University	1862
18	003184	University of Oklahoma	NLG
19	003471	South Dakota State University	1862
20	003529	University of Tennessee	NLG
21	003531	University of Tennessee at Martin	NLG
22	003642	Texas Southern University	NLG
23	003652	University of Houston	NLG
24	003677	Utah State University	1862
25	003932	University of Wyoming	1862
26	003935	University of Guam	1862
27	007022	CUNY Lehman College	NLG
28	008841	College of Virgin Island	1862
29	010313	University of New Mexico	NLG
30	029013	University of Connecticut	1862
31	007104	Miami University	NLG
32	002976	University of North Carolina	NLG
33	001989	University of Kentucky	1862

CONTROL DATA
8100 34th Avenue South
Mailing Address/Box 0
Minneapolis, Minnesota 55440

June 12, 1984

Ken Garvey
House Agriculture Committee
1301 Longworth
Washington D.C. 20515

Dear Mr. Garvey:

Enclosed are two papers explaining Control Data's and Rural Ventures' business activities relating to agriculture and computers. These are in response to your request for information for the hearing on the computerization of the Agricultural Extension Service. The papers include information about the two firms' relationship with the Extension Service and the role the Extension has played in the development of our computer products and services.

I hope this information is useful to you. If you need anything additional, please contact me.

Sincerely,

Griff Kennedy

Griff Kennedy
Program Manager
Public Relations

(The paper on Rural Venture is held in the Subcommittee files.)

Control Data Corporation
Summary of Agricultural Products and Services Business and Relationship with the Agricultural Extension Service

Business Strategy

Control Data, primarily known for building and selling computers, data services, and financial services, entered the agricultural market for two important reasons:

First, the company believes that the potential for the use of computers in agriculture is enormous, and therefore, selling computer products and services in rural areas is good business. Secondly, Control Data's business strategy is to address society's major unmet needs as profitable business opportunities. Control Data's new agricultural business aims to improve the economic viability of rural areas by helping family farmers succeed and be contributing members of their rural communities.

In addition, Control Data's agricultural business is designed to aid small business formation and job creation in rural areas by helping locally owned rural businesses start up as licensed dealers and sell Control Data's agricultural products and services. The name of these products and services is ADVANTAGE™ and the local dealers are called ADVANTAGE dealers.

The first seven dealers are off-shoots of existing businesses, such as a bank, a hardware store, an accountant and veterinary clinic.

For example, one of the first dealers owns a hardware store in Bricelyn, Minnesota. He has set aside a section at the back of his store to be his computer services center. In the first few months of operation, some 150 farmers came into the center to use various services. He hired two people to work with him to offer the service and so a new business and two new jobs were created in his small town of 500 people. That's like creating 2,000 jobs in a metropolitan area such as Minneapolis and St. Paul.

During the next decade, Control Data plans to assist thousands of rural entrepreneurs like this establish new computer product and services businesses or add ADVANTAGE products and services to their existing businesses. The firm is currently seeking rural people interested in operating these businesses.

Agricultural Products and Services

The products and services, themselves, also were developed with strong concern for the future of rural communities and family farms. Control Data managed the design so that family farming operations could take advantage of knowledge delivered via the computer.

These products were not developed independently. Control Data contracted with major agricultural universities, agricultural experts and private companies to help develop the content. Although the Extension Service was not involved in the development of these products, four land grant universities were among those who received grants or contracts from Control Data to develop some of the educational programs. These universities are Michigan State, University of Minneosta, Purdue and the University of Georgia. Control Data then applied its expertise in assembling data and packaging it electronically into a product or service that will improve farm productivity and efficiency.

There are two types of computer-based products and services Control Data offers:

- Farm financial and production management production tracking systems
- Education and information oriented programs

The production tracking products include:

- SwineTRAK Production Tracking System
- DairyTRAK Dairy Herd Management System
- SheepTRAK Production and Management System
- AgCHEK Financial Management System

These are available two ways:

- As software farmers can purchase and run on their own on-farm computers.
- As services available for a monthly fee from the local dealer.

For example, a farmer needing to improve his or her financial management and recordkeeping could use the AgCHEK service from a local ADVANTAGE dealer. The farmer would receive special check blanks printed for his or her local benk account. Each check allows the farmer to identify what the expense was for. At the end of the month, cancelled checks are brought to the dealer where they are entered into the computer. Financial reports are then mailed to the farmer.

This program is being used by numerous farmers including a family in southern Minnesota that runs a farrow-to-finish hog operation producing about 2,000 hogs per year as well as farming about 750 acres of corn and soybeans. "With AgCHEK we know how much we spent for fuel, fertilizer and feed and we can divide that by our acreage so we know our expenses per acre. That way we know our breakeven point and how much we need to get per bushel at harvest time," the farmer said. "We kept records by hand before. But we prefer to get the computer print outs and examine them instead of spending hours trying to get all of our checks organized."

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When combined with other farm data, the AgCHEK printouts can be used as up-to-date decision-making tools. Farmers are better able to track management successes and failures because they have more current and complete information. At the same time, the service has simplified farmers' record keeping chores. This system gives farmers better day-to-day control over their operations, provides them with the financial documents required by their vendors and helps them monitor their profitability.

The SwineTRAK and DairyTRAK services provide detailed production management information in a similar manner.

The educational programs are designed to train new farmers and family members or allow experienced farmers to brush up on skills and techniques. The programs use Control Data's PLATO computer-based education and video materials to deliver the information.

For example, to take the PLATO program on feeder pig management, the farmer receives a printed outline and begins by reading written materials. Then the farmer sits at the computer screen and keyboard and moves through the course at his or her own speed. The computer provides information, uses graphics to illustrate (such as a diagram of a building suitable for feeder pig production), and tests the farmer on comprehension. The video materials provide an additional major element of the course by showing an expert demonstrating hog-raising skills, such as vaccination or clipping needle teeth. The farmer can move through the feeder pig program, progressively improving knowledge and skills. A wide variety of agricultural programs are available and more are being developed. The current list of PLATO agricultural programs includes:

Dairy Production and Management
Feeder Pig Production and Management
Hog Finishing and Management
Sheep Production and Management
Feed Grain Production
Forage Crop Production
Farm Business Fundamentals
Farm Recordkeeping and Analysis
Reading AgCHEK Reports
Tomato Production
Strawberry Production
Introduction to Beekeeping

Segments from several of these PLATO programs are available on videotape for agricultural and vocational school use.

Relationship with Agriculture Extension Service

Control Data and the Agriculture Extension Service have been working together to determine if extension agents can use computer-based materials to deliver information and education to farmers.

The Extension Services in Minnesota and Indiana currently are using Control Data computers, videodisc players and several ADVANTAGE educational programs. During the past four years Michigan, Wisconsin, Mississippi, Georgia and Missouri have also tested the educational materials.

Attached are a letter and a report from two Minnesota extension agents indicating that they found the materials extremely useful in delivering information to farmers in their counties.

AGRICULTURAL EXTENSION SERVICE

UNIVERSITY OF MINNESOTA

Carlton County Extension Office
115 Courthouse
Carlton, Minnesota 55718
(218) 384-4281, Ext. 123

13 January 1984

CONTROL DATA CORPORATION

Dear Sirs

I would like to comment regarding the Control Data Home Computer Courses currently being used by Carlton and Aitkin counties. These materials have greatly supplemented the materials we already have available, and have provided a new and exciting learning tool to the farm residents of Carlton County.

I know of instances where these materials have aided a family in starting a new farming practice, and other instances where the materials have helped convince a family that a certain farming enterprise may not be for them. Both, I feel are equally important.

The farm aid position has been essential in utilizing this equipment and helping in the farm decision making process. Thank you for the opportunity to use this equipment and I hope we can continue this good working relationship.

Sincerely,

Lee Raeth

G. Lee Raeth
County Extension Director and
Co. Ext. Agent, Agriculture

GLR/jlf

UNIVERSITY OF MINNESOTA, U.S. DEPARTMENT OF AGRICULTURE, AND MINNESOTA COUNTIES COOPERATING

Minnesota Agricultural Extension Service
FY - 1983 Progress Report

Date Submitted 28 day 10 Mo 83 Yr

COOPERATIVE EXTENSION SERVICE NARRATIVE ACCOMPLISHMENT REPORT

BRIEF TITLE (include State name in Title)

PLATO Tutorial Computer and Agricultural Program Aide

PROGRAM DESCRIPTION
- Emphasis
- Goals
- Scale/Size/No. of counties
- Innovations
- Linkage
- Clientele
- Rural/Urban

RESOURCES INVOLVED
- Cooperators
- Volunteers
- Special Funds

ACCOMPLISHMENTS
- What were impacts?
- Who benefitted?
- What were the benefits?
- Level of impact?
- Calculated costs?
- Calculated benefits?
- How impacts were measured?

FUTURE IMPLICATIONS
- Expansion/deletion
- Clientele yet to be served
- Research needed

TEXT: Minnesota has had the opportunity to utilize the newly developed Control Data Computerized PLATO tutorial programs under a C.D.C. Grant. This grant also provided an agricultural program aide used in working with young, inexperienced farmers as well as the PLATO programs. The PLATO system utilizes CDC computer, textbook, and video disks. On the farm PLATO programs included feeder pigs, sheep production, and bee keeping.

The Control Data grant was for approximately $60,000 for a one-year period of time utilizing three computers, texts and video machines along with one program aide.

Approximately 1,000 persons had an opportunity to view and have hands on experience in utilizing computer tutorial programs. Of these, 92 area farmers completed one of the three indepth courses offered. This represents a total of over 2,700 hours of individualized training.

After taking the course, at least four persons decided not to go into the enterprise they were considering when they realized the management involved. The estimated prevention of loss in just one of these nears $100,000. This is an example of a tool we have never had before that knowledgeably prevents the loss before it started. In one other known case the farmer expanded his operation. The program aide has been very successful on an individual basis with several dairy herds increasing over 2,000 lbs of milk per cow through his individual contact.

Control Data's material is excellent. Extension should consider them part of the agricultural educating team in this nation. Their materials presently get at the needs of indepth one-to-one tutorial teaching which we do not have the resources to provide. This is especially beneficial to those new to or considering farming.

The present grant has been renewed and we are now able to provide this material in a much larger area.

- Name and title
- Organization
- Address
- City, State, Zip Code
- Telephone

CONTACT PERSON:

J. David Radford
Area Extension Agent
Small Farm Programs
Cloquet Forestry Center
175 University Road
Cloquet, MN 55720
218 879-4528

Marvin Mickelson
Agricultural Extension Service
115 Courthouse
Carlton, MN 55718
218 384-4281

KEYWORDS are words and phrases that others will use when searching the data base of accomplishment reports. The Keywords List can be used as a guide for selecting words. In addition, words not appearing on the Keyword List may also be used. Separate each distinct word or phrase with a comma; do not abbreviate keywords.

FISCAL YEAR	1983
ORGANIZATION	Agricultural Extension Service
STATE	Minnesota
PROGRAM AREAS	Agriculture
PROGRAM THRUST (Critical Concern)	Developing management capabilities & increasing productivity.
PROGRAM COMPONENT (Short Title)	Livestock Production
SUBJECT MATTER AREA	Animal Production, Computer Use, Decision-making
COMMODITY/SUBJECT SUB-SET	Beef, dairy, pork, bees, livestock
IMPACT/RESULT	Decision-making Improved Knowledge Gained
AUDIENCE	Farmers
METHODS	Computers, Home Learning Packets, Video Disks

Cost-Effectiveness Information

QUANTIFIED IMPACTS *Measurable social or economic consequences*	Re-enter impact keyword	Enter quantity (economic or social)
	Decision-Making Improved & Knowledge Gained	1,000 persons opportunity to view & have hands on computer experience.
		92 completed course 2,700 hours tutorial training
		4 farmers decided not to change into new enterprise.
VOLUNTEER TIME (OPTIONAL) *(Average local hourly wage multiplied by hours equals dollar value)*	Hours	Dollar Values
ESTIMATED PROGRAM COSTS (OPTIONAL) *(Multiply number of staff years expended by cost of one FTE.)*	Staff Years: *(Include specialists, agents, paraprofessionals and administrators, etc.)* Dollars:	

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Agricultural and Applied Economics
231 Classroom Office Building
1994 Buford Avenue
St. Paul, Minnesota 55108

June 12, 1984

Dr. Kenneth Garvey
Committee on Department Operations,
  Research and Foreign Agriculture
Committee on Agriculture
U.S. House of Representatives
Room 1301 Longworth House Office Bldg.
Washington, D.C.   20515

Dear Ken:

This is to follow-up on my letter of May 17. Enclosed is a copy of the final version of the paper that I presented at the American Association for the Advancement of Science, "Policy Dilemmas Created by Agricultural Scientific and Technological Innovations." It is a considerably reworked version of the paper on "Institutional Constraints on the Effectiveness of Agricultural Research" that I enclosed in my previous letter.

Sincerely yours,

Vernon W. Ruttan
Professor

VWR/er

Enclosure

Draft
May 29, 1984
Revised

POLICY DILEMMAS CREATED BY AGRICULTURAL SCIENTIFIC AND TECHNOLOGICAL INNOVATIONS

Vernon W. Ruttan
Department of Agricultural and Applied Economics
and
Department of Economics
University of Minnesota

Paper presented to symposium on Dilemmas in U.S. Agricultural Research Policy in the 1980's, American Association for the Advancement of Science, New York, May 25, 1984 (New York Hilton, Rinelander Center, 9:00 a.m. - 12:00 noon). The author is indebted to C.B. Tanner and E.H. Class for comments on an earlier draft of this paper.

During the last several decades the agricultural research system has been criticized and defended from a set of populist, scientific and ideological perspectives. At the risk of some oversimplification it may be useful to characterize these criticisms along the following lines.

The populist criticisms view agricultural research and the technology that has been generated by agricultural research as responsible for the displacement of small farms and farm workers, as a source of the decline of rural communities, as a cause of deterioration in the quality and safety of food and as an assault on the quality of the environment. Thus, in the populist view, agricultural research is regarded as a powerful instrument of technical and social change that has been captured by organized agribusiness and has misdirected its energies against the people and the institutions that it was designed to serve.

In contrast, a criticism that has often been directed toward agricultural research by the general science community is that agricultural research is not good science. A central element in this negative perception of agricultural research seems to be that it has been funded primarily through institutional support than through competitive grants. A second element is that a relatively high share of agricultural research is directed toward technology development rather than to the generation of new knowledge. These criticisms by the general science community reflect an ambiguous attitude toward technology development. While generally conceding that the investment in agricultural research has paid high social dividends in the past there is a concern that the system is loosing its capacity to make comparable contributions in the future.

The ideological criticism rests on the perception that public research support should be confined to the basic sciences and that the private sector should be primarily responsible for applied research. The proponents of this view tend to avoid questions of the articulation or synergy between basic and applied research. There is also an even greater reluctance to address the problem of how to assure research performance in those areas of technology development whereprivate incentives are inadequate to generate an economically or socially optimum level of research.

In characterizing these criticisms in a somewhat oversimplified manner I do not wish to imply that there is not a substantial element of validity in each criticism. The agricultural research system has been less than adequately responsive to the needs of many elements of its potential constituency, particularly in the sunbelt fringe where the politics of agricultural research have often reflected an inequitable distribution of political resources among larger than family farms, family farms and farm workers. The agricultural research system has been criticized by its partisans as well as its critics for devoting excessive resources to applied research that has little application - or application for only a limited clientele. And the appropriate allocation of responsibility for research between the public and private sector is an issue that must be continuously reexamined in response to institutional, scientific and technological change. Each of the criticisms, though perhaps excessive, and often not well informed, has generated response and reform in the agricultural research system.

Some of these issues that I have referred to above have been dealt with more fully in my book on Agricultural Research Policy and in my 1984 Morrison Memorial Lecture. In this paper I would like to turn to some of the institutional constraints that act to limit the effectiveness of agricultural research. These institutional constraints will be discussed under headings: (a) distortions in economic incentives; and (b) distortions in political incentives. In closing I would like to refer to some dilemmas that will continue to face the U.S. agricultural research system as it continues to evolve.

My comments on these constraints will be guided, or at least informed, by the theory of induced technical and institutional innovation. Over the last several decades advances in economic theory and the accumulation of empirical evidence has tended to confirm that the rate and direction of technical change can be interpreted as largely endogenous to the economic system - as induced by differences or changes in resource endowments and in relative factor and product prices.

To the extent that the underlying forces that act to induce the demand for technical change and the derived demand for new knowledge are obscured by distortions in the behavior of market or non-market institutions the rate and direction of technical and scientific change will be biased. And the rate of return to the resources that society invests in agricultural or any other area of research will be reduced. There is a potentially high payoff to institutional innovation that would act to correct the distortions in the economic and political markets in which the resources to support agricultural research are generated and in which the technology resulting from agricultural research is adopted.

Distortions in Economic Incentives

It is quite clear that both public and the private sector agricultural research institutions respond to the signals that are cast up by market forces that affect the profitability of agricultural production. When the market signals are distorted through market interventions or controls on resource use research is directed into low productivity activities. One can cite numerous examples:

(a) Policies that attempt to raise commodity prices by acreage controls, thus making land more scarce and more expensive, induce the research system to place excessive emphasis on the development of land saving technologies. The history of tobacco research represents perhaps the most extreme example of such distortions.

(b) Policies that attempt to hold prices to producers at excessively high levels induces the allocation of research resources to the development of substitutes. For example, the maintenance of domestic sugar prices at roughly double world prices have encouraged research and development in support of a corn sugar industry that is in turn dependent on the continued maintenance of domestic sugar prices well above world market levels.

(c) Policies that impose constraints on interregional competition or interregional (or international) movement of commodities induces research resources to support production in areas that are not best suited to the production of the commodity. The system of local milk marketing orders, which restricts the interregional movement of milk, has encouraged a shift in milk production from the low cost to high cost producing areas and has induced the allocation of research resources in support of production in such areas.

(d) Policies which provide tax incentives for investment direct research resources to the support of activities which reduce rather than enhance productivity. The accelerated depreciation and capital gains provisions of the tax code have diverted much of farm management research from technology management to tax management.

Other examples could be cited. But even without more examples a clear generalization emerges. Bad economic policy is a burden on the productive use of research resources. By distorting the returns to economic activity it diverts research resources into unproductive effort. If the returns to agricultural research were low the loss to the nation would also be low. But because the returns to investment in agricultural research are high the loss from the misuse of research resources is also high.

Distortions in Political Incentives

The constraints listed above impinge on the research system primarily through the systems attempts to respond to its economic environment or to the economic forces operating on research system clientele. In contrast a number of political constraints operate on the system more directly. A number of examples can be cited.

(a) The location of public sector agricultural research facilities is almost always a political decision. Often little attention is given to the natural resource conditions that influence whether a research site will be a productive research location. Even less attention is often given to the institutional environment that affects the productivity of a research laboratory or center. It has become clear that location of a research laboratory where it has easy accessibility to the staff and infrastructure facilities of a major research university can substantially enhance research productivity. Similarly, locations of a small research laboratory at a remote location imposes a substantial burden on the development of an effective research program. There may, of course, be significant trade-offs between the resource and institutional criteria. The need to work with unique resource endowments may dictate the location at sites that lack much of the institutional infrastructure normally needed to support an effective research program.

But these trade-offs are seldom subject to careful cost-benefit calculations. Instead, political considerations often dictate a location that has neither a favorable resource or a favorable institutional environment. The burden on a research system imposed by inefficient location decisions are not easy to correct. The closing of public research facilities at an inefficient location generates political pressures that are exceptionally difficult to overcome.

(b) Political pressures have acted to bias research toward the support of commodity production and to limit research on the effect of intensification of commodity production on soil and water resources, on environmental amenities and on rural community development. It has for example, become conventional to ask how the allocation of commodity oriented research resources are related to the value of commodity production (even if the value is biased by market interventions as suggested above). But the question of the appropriate balance between commodity and non-commodity oriented research is seldom faced explicitly. The relationship of the appropriate allocation of non-commodity research to, for example, natural resource and human resource related research - to research on soils and research on human nutrition, for example - is rarely treated analytically or even explicitly. And I am unaware of any body of knowledge that will support an objective test of a hypothesis regarding the appropriate, or most efficient, allocation of research resources between research designed to produce new knowledge and research directed to technology development.

An important challenge to social science research is to develop more adequate methodologies for the allocation of research resources. In the absence of more effective analysis both the level of resources devoted to non-commodity research, the allocation among natural and human resource oriented research areas, and the allocation between the generation of knowledge and the development of technology will continue to be made primarily on political grounds.

(c) There is growing evidence that the human resource base, the pool of trained scientific manpower capable of conducting agricultural research, has become less adequate relative to needs over the last decade or so. A typical response to this problem is to seek ways to allocate resources in support of pre- and post-doctoral training. It is doubtful that such efforts can succeed, however, in the absence of a more attractive career incentive structure that the present civil service salary structure provides. The salary structure in the federal science agencies has become a disaster. It is an obstacle to the retention of the most able scientific talent and to the recruitment of the promising graduate students and post-doctoral candidates. And its impact on agricultural research is occurring at a time when private sector demand is resulting in substantial increases in the financial inducement in those areas of science that are particularly significant for the strengthening of agricultural research. One possible option is the establishment of a separate "scientific service" that would be more suited to the needs of the federal science agencies (including the Agricultural Research Service).

Some Research Policy Dilemmas

This discussion, and my earlier work on rates of return to agricultural research, leaves me confronted with two serious dilemmas that I see no obvious way to resolve.

The first dilemma is why the U.S. continues to underinvest in agricultural research. If we exclude private sector research that is directed primarily to product differentiation and public sector research that is closely related but not directly relevant to agricultural production (such as research on how to grow grass on freeway margins) it is doubtful that the public and private sector together spend as much as $3.0 billion on agricultural research. Yet the rate of return estimates that are available to us indicate that the U.S. is depriving itself of substantial economic growth as a result of this underinvestment. The evidence also suggests that this underinvestment extends throughout the civilian economy and not just in agriculture. Part of the answer to this question must be found in the peculiar way that the government intervenes to regulate agricultural production and marketing. Until we manage to extend the deregulation of markets to include agricultural markets both producers and consumers will be prevented in sharing in the full benefits of technical change by a set of policies that converts the potential resource savings from research into government program costs.

A second dilemma stems from the demand for more effective planning of agricultural research. In spite of the demonstrated high rates of return to agricultural research it is clear that parts of the system are obsolete, inefficient, and unproductive. On the surface it would appear that more effective integration of the federal-state system combined with more careful planning of research facility and program development would be at least a partial answer to this dilemma. But the information necessary for effective planning of research does not, and cannot reside in central planning staffs. This knowledge resides only at the level of the individual scientist or scientific team. There seems to be no way to escape from a conclusion that a productive scientific system must leave substantial room for what might otherwise appear as redundancy. It is important to ask whether this redundancy can be planned. I have sometimes argued in favor of planned redundancy rather than mindless redundancy. But I really do not know whether productive redundancy can be planned. But I do know that redundancy is a necessary condition for research efficiency.

USDA WITNESSES—ARS REDIRECTIONS AND USDA VIEWS ON ALL ISSUES

WEDNESDAY, JUNE 13, 1984

House of Representatives,
Subcommittee on Department Operations,
Research, and Foreign Agriculture,
Committee on Agriculture,
Washington, DC.

The subcommittee met, pursuant to call, at 9:40 a.m., in room 1302, Longworth House Office Building, Hon. George E. Brown, Jr. (chairman of the subcommittee) presiding.

Present: Representatives Penny, Volkmer, Olin, Roberts, and Gunderson.

Staff present: Peggy L. Pecore, clerk; William A. Stiles, Jr. and Gerald R. Jorgensen.

OPENING STATEMENT OF HON. GEORGE E. BROWN, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. **Brown**. The subcommittee will come to order.

I am pleased to welcome this array of officials from the Department of Agriculture to our hearings this morning.

Over the past week, we have conducted hearings that included biotechnology research, long-range planning, an effort to implement the recommendations from the "Extension in the 1980's" reports and on higher education needs.

It is timely that the Department witnesses wrap up this set of hearings by offering their views on these issues.

The hearings began last Wednesday on an ironic note. As witnesses were expressing the urgent need for a high quality USDA biotechnology research program, I was compelled to go to the House floor to participate in a discussion aimed at helping the Members to understand this very topic.

I am hopeful that there will be an improved reception to the Department's biotechnology initiative in the conference on the Agriculture appropriation bill.

We must establish more firmly that USDA has a unique role among Federal agencies in operating an agricultural biotechnology competitive grants program. We learned last week about the urgent needs in this area.

One of the greatest needs is for more multidisciplinary research. This was an important element of the program proposed by the NASULGC Committee on Biotechnology. The private McKnight

Foundation testified about its very innovative interdisciplinary grants program that emphasizes graduate student research.

USDA must find ways to stimulate the multidisciplinary research needed to fully investigate the basic processes of life at the cellular and genetic levels.

USDA needs to publicize its biotechnology program plans to prove that it can operate a high quality, innovative competitive grants program. We can use this information to strengthen the case for full funding of the initative.

The subcommittee also heard testimony on regulatory and public benefits issues of biotechnology. USDA should take a leadership role in assuring the public that safety will be guaranteed. Attention must also be given to organizing the research to ensure the broadest possible public benefits.

We will be interested in hearing the Department's assessment of the long-range planning and priority-setting process required by title XIV. Many reports have been generated. Are they having an impact on the system?

Yesterday we looked at several issues in Cooperative Extension and higher education. We also look forward to hearing the Department's views on these issues.

Finally, the Agricultural Research Service is now trying to implement its long-range plan. An innovative technology transfer plan has also been developed. Today the Department officials will update us on ARS's long-range planning process. We value this opportunity for a good discussion with the Department. These hearings provide us with an opportunity to be mutually supportive in our joint efforts to strengthen the food and agricultural sciences.

I would like to ask Mr. Olin if he has any comments to make at this time.

Mr. Olin. No, thank you.

Mr. Brown. This imposing array of witnesses makes me wonder how everything is going back at the store, but we think that maybe it can survive for a couple of hours, and we are very pleased to have you all here.

I think this is a fitting, not conclusion, but at least wrap-up for the very important issues that we have been discussing, and we welcome you all.

Dr. Bentley, you may proceed in the fashion that you have planned to do.

STATEMENT OF ORVILLE G. BENTLEY, ASSISTANT SECRETARY, SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE, ACCOMPANIED BY BRUCE CONE, DEPUTY ASSISTANT SECRETARY; TERRY KINNEY, ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE; MARY NELL GREENWOOD, ADMINISTRATOR, EXTENSION SERVICE, DENZIL CLEGG, ASSOCIATE ADMINISTRATOR; J. PATRICK JORDAN, ADMINISTRATOR, COOPERATIVE STATE RESEARCH SERVICE; JOSEPH HOWARD, DIRECTOR, NATIONAL AGRICULTURAL LIBRARY; KEITH R. SHEA, ASSOCIATE CHIEF FOR RESEARCH, FOREST SERVICE; ROBERT BUCKMAN, DEPUTY CHIEF, AND PAUL O'CONNELL; ED KENDRICK, CHIEF, OFFICE OF GRANTS AND PROGRAMS SYSTEMS; AND JOHN E. LEE, JR., ADMINISTRATOR, ECONOMIC RESEARCH SERVICE

Mr. BENTLEY. Thank you, Mr. Chairman and Mr. Olin. It is a pleasure to be here this morning.

Let me begin by saying how much we appreciate in the science and education agencies and other agencies of the Department the thoughtfulness and the objective manner in which these oversight hearings are being conducted. They have been most supportive to us, and we view them, for our part, as being valuable parts of the discussion and the interchange, and the first thing we want to say is how much we appreciate this opportunity and the exchange of information that we have enjoyed as a part of these discussions.

I have not been to the hearings myself, but I have heard reports from the conversations, and I know that we share in the enthusiasm I think your opening statement projected.

I might say also that, as you would expect, we would be very biased in support of some of the comments you made concerning the outlook for the work that we have done.

My colleagues are here with me. I will try to provide an opening statement that covers many of the general topics that have been made a part of agenda, but that as the statements from my associates are presented, I hope we cover the major questions you have, and, if not, obviously we would invite opportunities to expand on them.

I have a prepared statement, and I would ask that it be made a part of the record.

Mr. BROWN. Without objection, it will be.

Mr. BENTLEY. I would like, then, to take a few minutes to review the statement and call attention to some of the major provisions in it.

I can divide my remarks into three general groupings. One has to do with the response of the Joint Council on the Food and Agricultural Sciences. In terms of reports, it has already been referred to.

There are some questions that have been raised in the charter and in the documentation that we received prior to the hearings, and I will comment on some of those.

Finally, I want to talk a bit about an interagency effort that we are taking on behalf of the Department to help find answers to some of the policy questions that relate to science and education in terms of the next farm bill.

Let me then start by making reference to a topic that you are very familiar with—that is, the reports from the Joint Council on the Food and Agricultural Sciences.

I have before me the major documents, and I will merely hold them up as reference to the various publications and call attention to each of the—the colors of the documents, but also to the fact that there was a background paper in reference that was developed by staff that has ably assisted the joint council. It represents contributions from some 40 authors in 16 papers that have been drawn from the land grant college system, from industry, and from the Department.

I might say that I know Dean Anderson joins me in saying we are proud of this effort, and we think it's an important step, and we know that you and your committee have had an important part in having that take place.

There are two things about the reports that I want to stress in my comments. The first is that the mandate that we obtained through the 1981 farm bill set the groundwork and the framework for the planning, and it provided an opportunity to bring the performers of agricultural science programs, of education programs, of extension activities together to talk about emerging problems. And most important of all, I think, is the communications among participants as to how they viewed priorities and directions the system should take.

After all, it is an extensive system, and it involves a number of organizations, as you know very well, and to define a device to promote communications and to develop shared ideas is a task that requires some effort and requires understanding and the support of not only the Department but the Land Grant College Association, the non-land-grant universities, agricultural universities, industry, and so on, and we think we've achieved a certain amount of success in this effort, but we recognize, of course, that much more is to be done and that the job is never finished when we talk about planning and looking ahead.

The other comment I would like to make about the reports is that we view the needs assessment document as a long-term document, whether it is 10 years or 20 years, but it is one that is supposed to set some directions for the future, and I believe it accomplishes that goal.

But also we don't want these reports to stand on shelves or to fill obligatory responsibilities under the legislation. We want them to be active, useful documents, and we are seeing good signs of that. We are encouraged that the documents are standing the tests of usefulness to the participating units—organizations within the science and education enterprise. We are getting letters from universities, for example, that talk about using these documents as guides for their own internal planning activities that they are now undertaking or are in progress.

Others are talking about using the documents as a way of communicating the priorities, and the needs, and the opportunities for science and education to the university systems as a whole, to leaderships within States, the legislative branches, various advisory groups, and so on.

We think this is most encouraging and would be an example of how this process will help shape the future directions, because the Joint Council itself is not an organizing, operating group, it is a coordinating device, and we can only achieve success as a council if the system uses this as guides for planning the future.

I think as the presentations unfold this morning you will hear more about this, and I think you have also heard about it in other testimony that has been presented during these overview proceedings of the last couple of weeks.

Now, one of the questions raised in the charter had to do with the biotechnology initiative. I think it is appropriate to point out here that the topic itself merits consideration, because it is an exciting concept or way of focusing new developments and new tools from biological research on through the needs of agriculture, but it also takes on added interest because it occurs at a time when there is really a ferment in all of the agricultural sciences, whether it be in industry, or in Government, or in universities.

New questions are being asked, and biotechnology is one of those important ones. It raises some of the questions that have been around for a long time or really puts them into new focus—the matter of resource allocation, the appropriate role of the Federal performers or of the university system, the experiment station—Extension Service, the matter of some regulatory concerns takes on new meaning in new developments in science—what potential have they for agriculture in the future.

As I am sure you have heard many times, and our deliberations of the Joint Council brought this out, along with numerous studies and conferences that have been held on the subject over the past 3 or 4 years, there is a potential for biotechnology to reduce losses from diseases, to deal with the question of nitrogen fixation in plants, and creating new organisms that are more efficient in converting, say, waste products such as lignin and cellulose into carbohydrates; it shows promise for commercial application in food processing and in other developments that relate thereto that would help to improve the efficiency and the productivity of our system and would try to help deal with some of the adverse impacts that we have on resource use.

We, in agriculture, could improve the quality and the safety of agricultural products.

But, most of all, I think it has the great potential for giving us some basic information about biological processes that will help us solve some of the continuing problems that we have in the management of biological materials, wherever it may be, but certainly that is a big part of agriculture when you think of the dynamics of the soil, of soil-plant interactions, the plant-animal interactions, human nutrition, environmental questions, and so on.

So we feel that this is an appropriate area and one that needs to be given a lot of attention, and this is why we address the matter with regard to the budget recommendations that have come before the Congress through the executive branch.

There is another question that has come up from time to time, and it was mentioned in the charter for the hearing, and that is the emphasis being placed on biotechnology—does this distort the emphasis on other priorities that have been identified through the

Joint Council planning process or some of the continuing high priority needs of research, and I will mention a bit about maintenance research a little bit later.

I want, though, to point out that because of the stress on biotechnology at this time, that does not mean that other priorities are being ignored. Both within the Federal system and within the State system, the administrators and science program leaders are looking at the program mix and for opportunities that come along regularly, in the normal activities within these organizations, for reallocation and redirection of resources to high priority areas.

So while we have experienced budget constraints and cannot address all of the priorities, I am fully confident that all of the priorities that have been identified through the process are gaining attention and are being used as planning devices, not only for the current budget year and next year but in long-term planning for these programs, and I think that is the value of the national effort here in terms of the individual agencies.

As a way of approaching this, Mr. Chairman, we in the Joint Council are talking about some of the priorities that are not necessarily identified as major initiatives in the executive budget, and two areas would be forestry and conservation.

We are having discussions within the groups within the Joint Council about how we should best approach the concerns that relate to basic research, biotechnology, new program directions, educational needs, international dimensions, the future of the system, and funding trends.

I would say in connection with forestry research that the people with whom we are involved in the Joint Council would think that here is an area that could be reviewed by your committee next year as it relates to the science and education. Such a review would involve the Forest Service, the Soil Conservation Service, and within the Federal agency ARS, and within the various land grant universities, whether it be in research or extension—focusing on issues dealing with erosion, productivity relationships, the offsite effects—or nonpoint pollution—of erosion, water management, range conservation, and incentives or various ways to encourage the application of these practices to our land.

Addressing again another topic that was mentioned in the charter in the hearing book material that was presented was the matter of encouraging the Joint Council, in developing their evaluation reports, to begin to relate achievements and progress on a year-to-year basis with the developments and progress made in implementing priority recommendations.

We think this is a good recommendation, and we will seek to do this not only beginning this year but in subsequent years, because there is a need for the Joint Council to carry on an evaluative process. In other words, when we say we are going to go in a certain direction, do we in fact do that, since there is a multiplicity of decisionmakers involved in the process, and so on.

Another area that was mentioned that needed to get attention is the economic significance of improved or new technologies and potential spinoff in terms of social, environmental, and scientific implications.

This, we think, is important, and we hope to give some attention to it, along with such matters as supply/demand projections that were also mentioned as a part of the needs in terms of future directions for the Joint Council activities.

I might say that one of the ways we are approaching these questions—not all of them under one rubric—but one way we are approaching it is, having the Joint Council staff draw together representatives from the agencies in science and education to define issues.

In this case, Gary Taylor of the Economic Research Service is now helping with the development of the Joint Council reports. He brings expertise and knowledge of these issues that will help a great deal to adding an economic dimension to our planning efforts and identifying linkages among the various programs. Through such discussions linkages can be strengthened and the economic impact that the recommendations might have on the profitability of agriculture and on policy issues that relate to the development of plans for agriculture will be better understood.

Turning now to another question—and this one has to do with the matter of nutrition and how, in the planning process, we can give more attention to the relationship of productivity to changing human nutrition requirements—this of course has been done for a long time, but is there an opportunity here to show closer relationships and demonstration of the totality of the system of food and fiber production and its utilization.

We are looking into this matter and trying to find new ways to illustrate this point and emphasize the importance of the relationships.

Certainly one way is to get more communication among the scientists that deal with human nutrition, with the plant and animal production scientists, and producers, as we talk about the changes in the market that might come about due to changing food habits, changing market conditions, and changing economic conditions. Moreover, changes in the food system are occurring through the impact of science and new technological innovations and this dimension needs attention too.

Now to a few general comments about the future. One area that we think needs to be brought to the attention of our own system as we plan research but to those of you concerned with policy and direction of research, and that is the importance of maintaining what has been described by many as maintenance research.

As the base of technology for agriculture and the whole system of food production, processing, distribution, and the technology that is related to fiber production processing and so forth get more sophisticated, the amount of technology involved increases, and thus there is a need to be sure that we keep that technology current—that is, to see to it that it doesn't depreciate in value and get out-of-date. Obsolescence is always a problem, and it requires attention, and maintenance research deals with that particular idea.

As budgets increase—as programs move along, we are finding that larger portions of the funds available for research and extension education activities have to be devoted to the maintenance of the quality of the research. To update material having to do with plant, insect, animal disease and resistance is one example.

How do we apply knowledge gained about the management of our resources on a continuing basis is important, and I think you will hear reference to that activity in each of the presentations that will be made by my colleagues after I finish my presentation.

The next area that I would like to be sure we stress is that our deliberations, I think, in the Joint Council, bringing together, as we do, representatives from the various activities of the national Land grant Universities, the experiment stations, the extension services, the teaching programs—which includes the non-land-grant colleges of agriculture—and industry stresses the need for a concerted effort to train more scientists for now and the future.

There is a fundamental relationship between the quality of an activity within a society as a whole and certainly within education and research that says that the progress and realizing the potential depends upon the quality of the people involved.

Whether it be the students, the teachers, professional leaders in industry, or professional leaders in government, they have to be strong intellectually, deeply committed, and also have the capacity to provide leadership.

We think this is an area that we have successfully brought attention to within the system and with those that are concerned with the future of agriculture, whether it be from industry, or government, or wherever within our community.

I want to close with two observations. The first has to do with a development that I think will be helpful to those concerned for science and education, and that is the decision as a result of the Secretary's effort to begin some planning activities for the 1985 farm bill.

Deputy Secretary Lyng has been asked to chair a working group of the Cabinet subcommittee to deal with six major areas, and I won't go into the others. They would be, as you would expect, farm commodity programs, trade, food assistance, credit, and so on, but one of those areas has to do with research. The Deputy has asked that I Chair that subcommittee and that it be made up of representatives from HHS, NSF, OMB, OSTP, and we have also invited representatives from the Departments of Interior and Commerce as a means of obtaining added expertise on water, land, and wildlife management from such agencies as BLM, Geological Survey, and the Fish and Wildlife programs.

This subcommittee is now working on developing a paper talking about the future of science, the directions that science policy should go in placing this into a background document.

I stress that this document is not to deal at this time with policy issues but, rather, to give an update on the state of the art—where we are and what things are likely to happen in this area that will have an impact upon the future directions of agriculture.

Of course we are delighted that we have that opportunity, and we are going to draw heavily upon the work, Mr. Chairman, that has been done and reported in these reports that I have just referred to here in developing this paper.

I want close, finally, by saying that we realize the complexity of the food and agricultural issues that we face in this country, their implications on a worldwide basis, but it is our particular responsibility—or mine either, for that matter—to deal with those particular problems—the matter of profitability, marketing problems, et cetera.

We think that science and education has an important part to play in this, in finding answers to some of these difficult questions.

The answers are not going to come, more than likely, in a very quick fix, so to speak, but, rather, it's going to come through the concerted efforts of many people within government, within education, within research and science, and within the industry, but, in reaching a decision, there is going to be a need for sound information and information that is directed toward answering problems for the future.

Then let me say that even more important than the problem side is that in this country we must not lose sight of potential and opportunity, because we must not let just the problems of the day overshadow all of our thinking too much, so that we miss the potential for applying new ideas, new innovations, wherever they come from, but certainly from science, into this wonderful mix and blend that makes up our food and agricultural industries of this country and of the world.

We think that the future activities of the joint council will be exciting and challenging as we work through a ferment going on throughout science and technology as it relates to the food and fiber industries.

Mr. Chairman, I appreciate the opportunity to make these remarks, and now I would like to turn—however you would please to have us do—to presentations from my colleagues on these matters.

Thank you.

[The prepared statement of Mr. Bentley appears at the conclusion of the hearing.]

Mr. BROWN. Let me ask my colleagues on the subcommittee who wish to make any comments at this time.

Mr. OLIN. Mr. Chairman, I would prefer to wait until the other speakers have spoken.

Mr. ROBERTS. That is fine with me, Mr. Chairman.

Mr. BROWN. All right.

Let me just say, Dr. Bentley, I think you have well described the situation that we face. It is a period of ferment. We are seeking to look at our roots in the past and see if the directions that we have been going will meet the problems of the future. That is the purpose of all of these reports and processes.

The reports themselves are not nearly as significant as the processes by which we generate this and the extent to which we are learning and developing ourselves as we go along. I am sure I don't need to tell you this.

One of the problems that the Congress frequently creates is what you might call the micromanagement problem. There is an obverse of this—the macromanagement problem. Sometimes we do too much; sometimes we don't do enough.

We don't really know, and we may have, in committing the department to this extensive exercise that has been gone through—we may have done too much, or we may have set in process something which is valuable for the present time but may be unnecessary 10 years from now.

In looking at what you are doing, I hope you would keep this in mind and advise us as to whether or not we have committed these sins of trying to give you too much direction or not enough and, if so, what the proper response to that is.

I think we all perceive that we are in the process of change and that we can't change individual sectors or portions of this without seeing what the impact is on all of them, and that of course accents the value of these reports, because it tends to show the relationships between all of the different aspects of this overall problem.

So let's proceed with that thought in mind, and you may introduce Dr. Kinney if he is going to be the next speaker.

Mr. BENTLEY. Dr. Kinney is the Administrator of the Agricultural Research Service and has been leading a major effort to look at the current programs and directions that the Agricultural Research Service should take, and I am pleased to introduce him for his presentation at this time.

STATEMENT OF TERRY B. KINNEY, JR., ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. KINNEY. Thank you, Dr. Bentley.

Mr. Chairman and members of the subcommittee, I appreciate the opportunity to appear before you today.

Dr. Bentley has given you an overview of the agricultural research system, and I'd like to more fully discuss the activities that concern the Agricultural Research Service—those that you asked us to address.

I will summarize my remarks as concisely as possible, and then I'll present for the record the full statement.

As a centrally managed Federal research agency, ARS is uniquely qualified to implement a national level mission for the benefit of producers and consumers of the Nation's agricultural products.

In order to achieve its mission, ARS has developed a long-term ARS strategic program plan and a 6-year implementation plan. These establish our research priorities.

This committee is well aware of the goals and objectives of those plans, Mr. Chairman, such as addressing the current and future needs of agriculture for managing its natural resources, producing, and marketing food and other products, and providing nutritious and wholesome foods at reasonable costs.

The plan describes the kinds of research that scientists of ARS think will be needed to achieve the objectives.

The 6-year implementation plan is a statement of ARS program priorities and overall research direction for the planning period 1984 to 1990. This plan helps to guide ARS scientists who develop research projects, along with other agency decisionmakers at all organizational levels. It also provides important information to organizations that cooperate with ARS, use ARS research findings, or provide resources for ARS activities.

Plans are never static. We must and will respond to expected and unexpected problems, technological advances, research opportunities, and to changes in public policy. Therefore, the 6-year implementation plan is reviewed and updated as needed, but no major changes have been made to the plan.

In addition to the development and implementation of the ARS program plan, ARS has undergone organization changes here at headquarters and more recently in regional and area offices.

Every change that has been made to date has been with the purpose of improving the organization, the focus on national research priorities, improving overall management responsiveness, improving accountability, and streamlining communications.

This year, Mr. Chairman, we have reduced the number of areas and centers in ARS from 25 to 11. The area directors now report directly to me, thus assuring control of program and funds from headquarters rather than from 4 regional and 25 area or center offices.

In addition to these significant changes in line research management and administrative management, we have reorganized the national program staff in order to strengthen its national overview, national responsibilities, and national functions.

Through these actions, ARS has identified over 350 additional positions that can be and are being assigned to research.

There is a correlation between ARS research priorities and the needs assessments and priorities that have been developed by nationally oriented organizations.

Mr. Chairman, in furtherance of its continued effort to assure that our research meets the needs of American agriculture, ARS is moving forward in both planning and implementation to strengthen and focus on the biotechnology and bioregulation sciences.

ARS and the National Academy of Sciences have initiated a study, "A National Strategy for Biotechnology: Science and Technology in Agriculture." The study is due to be completed this September. It will be of great value to our agency as we move into this area in the future.

Another step to enhance our programs in the new biotechnologies is the establishment of the Plant Gene Expression Center at our Albany, CA, facility. This laboratory will concentrate on the basic studies that will generate fundamental knowledge and technology that will undergird any practical application of plant gene expression. This center will strengthen our cooperative programs with Federal, other public, and private research groups.

ARS is currently redirecting resources saved from management realignment into several biotechnology program initiatives, principally at our northern and southern regional research centers.

Mr. Chairman, research results must be put into the hands of those who need them. ARS has made major progress in developing an ARS technology transfer plan and has recently appointed a full-time technology transfer coordinator.

With the permission of the subcommittee, I would like to include this plan in the record of these hearings. I have a copy of the ARS technology transfer plan that I'll make available to the chairman, and I think there are several other copies available for committee members. So I will make that available.

Mr. Brown. Without objection.

[The plan is held in the subcommittee files.]

Mr. **Kinney**. Mr. Chairman, while we have our research and technology transfer plans in place, we would be remiss if we didn't consider the implications of recent studies regarding the future availability of scientific expertise in the food and agricultural sciences.

The higher education community and colleges of agriculture are currently at a critical juncture in terms of program quality and enrollments. The ability of American agriculture to continue as a leader in world food exports is dependent on the nation's supply of agricultural scientists and professionals.

The Office of Higher Education Programs has been quite actively involved in a variety of projects with cooperating institutions to encourage and assist colleges of agriculture in strengthening their capacity to produce the requisite graduates and professionals in the food and agricultural sciences.

Cooperative ventures with various universities and others have been initiated to address some of the critical areas in agricultural higher education. I would like to provide more detailed information for the record, and rather than go on with the details that are in my prepared statement, I will let them stand for the record, Mr. Chairman.

Mr. **Brown**. Without objection, Dr. Kinney, additional material will be included in the record or held in our files.

Mr. **Kinney**. Mr. Chairman, that concludes the summary of my comments, and I will be glad to answer questions now or later on. Thank you.

[The prepared statement of Mr. Kinney appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you, Dr. Kinney.

Mr. **Bentley**. The next presentation will be Dr. Pat Jordan, who is Administrator of the Cooperative State Research Service, and will summarize his remarks for the record. Thank you.

Dr. Jordan.

STATEMENT OF JOHN PATRICK JORDAN, ADMINISTRATOR, COOPERATIVE STATE RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. **Jordan**. Thank you, Dr. Bentley.

Mr. Chairman, Mr. Roberts, Mr. Olin, I am Dr. John Patrick Jordan, the Administrator of the Cooperative State Research Service, the science and education agency through which Federal research funding and planning is accomplished on behalf of the Department of Agriculture with the 52 State agricultural experiment stations, the 17 colleges of 1890, including Tuskegee Institute, the 62 independent schools of forestry, and the 26 colleges of veterinary medicine in 28 different institutions.

Most of these institutions are associated with organizations associated with the land grant university system, and you have heard from a number of the constituent organizations already.

I have a prepared statement for the record, Mr. Chairman, and would like to just summarize some of those points.

Mr. **Brown**. Without objection, the full statement will appear in the record.

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Mr. JORDAN. I would like to speak specifically to three charter issues—first of all, the relationship of the agency to the needs assessment report and its subsequent impact; secondly, the biotechnology initiative which, if funded, will be administered through the Office of Grants and Program Systems within the CSRS budget and; third, higher education and the role that research plays, specifically research funded at least in part by the agency through universities, in providing highly skilled scientists and technicians to meet the needs of agriculture in the 1990s and beyond.

The first of these, Mr. Chairman, has to do with the needs assessment study. That study provides a quality information base against which program planning and budgeting by the State agricultural experiment station system, including all of the units that I have identified already, can be done cooperatively.

By that I mean between the State agricultural experiment station system and the various research agencies within the Department of Agriculture, particularly the Agricultural Research Service, the Economic Research Service, and the Forest Service.

The State agricultural experiment station system has engaged in cooperative planning with the U.S. Department of Agriculture and with its neighboring States for many, many decades.

Such a system was formalized nearly three decades ago with the establishment of the Regional Research Program, which required the submission of coordinated proposals to the administrator of CSRS for approval.

Subsequently, a broader range of program planning was put into motion as a result of the 1966 National Plan for Agricultural Research, which again was done cooperatively between the National Association of State Universities and Land Grant Colleges and the U.S. Department of Agriculture.

The 1966 plan, Mr. Chairman—from that emerged a memorandum of understanding between the two organizations to form the Agricultural Research Planning Committee, often referred to ARPAC, the forerunner of the joint council of today.

That organization initiated the 5-year projection system which is still in use today. In fact, that 5-year projection system was formalized in the Food and Agriculture Act of 1977.

A key issue from the point of view of the agency is to fit the 5-year projections to the needs assessment report and subsequently be able to determine the quality of that fit. Deficiencies can be brought to the attention of the system through the National Agricultural Research Committee of the Joint Council.

Each organization receiving funding through the CSRS has received multiple copies of the needs assessment report and also the 5-year plan which is driven by the needs assessment report.

Consequently, the 1985–89 projections should be even more realistic than in the past, since they will be related more closely to the needs assessment report and the 5-year plan.

However, I would like to comment, Mr. Chairman, that the individuals that coauthored most of the articles in the needs assessment study have been deeply involved in the regional and national planning system for agricultural research, and, thus, even the projections that were made for 1983–87 are quite close to being on target.

The second area I would like to address is the biotechnology issue, one that's of high interest to members of this committee. It is one of the most exciting frontiers that agriculture has ever had an opportunity to participate in.

I would like to recognize, Mr. Chairman, the fact that the system was applauding last week your efforts to make points on the floor of the House of Representatives regarding this important opportunity for us.

Simply stated, biotechnology——

Mr. **Brown**. Dr. Jordan, if I may interrupt, they were watching because I was quoting you so extensively.

Mr. **Jordan**. Touche, sir.

Simply stated, biotechnology is the application of technological advances to improve biological performance, and the Biotechnology Committee of the Division of Agriculture of NASULGC, as you pointed out, Mr. Chairman, has defined biotechnology as the use of living organisms or their components in industrial processes.

In their reports, you will remember, sir, that they point out that this is not new to agriculture, but the impetus for greatly increasing the impact of biotechnology in food fiber and forest production, processing, and utilization is really the exciting new frontier.

Laboratory work in this area has been done for several decades. Now the opportunity to put it to work in the real world provides an ever increasing horizon for those of us engaged in agriculture. Two particularly good examples I think might be helpful.

[Picture shown.]

Mr. **Jordan**. This is a picture of a pair of genetically identical twin calves. They happen to be a cross between two breeds, with a Black Angus covering the color issue.

That is not all that unusual in agriculture, but what is unusual is that these animals were produced by the hand of man as clones. In other words, a single ovum fertilized in a cow was recovered, and when it got to the 60- to 100-cell stage, called a blastula, by micromanipulation and microsurgery, the genetic material was cleaved in half. Half of it was left in that original ovum. The other half was put into an empty ovum, a separate one that had not contained any fertilized material at all.

After a couple of hours in the particular medium, both of these ova were perfectly repaired and were ready for implantation into carrier or incubator cows.

Now the choice is, you could put them back into the same cow from which the ova were obtained originally—in this case, a single ovum—or you could put them in separate cows, and they don't have to be genetically related at all, they simply have to be in estrosynchrony. In fact, you can freeze—you can freeze the separated halved ova and hold them until the incubator cow is in the right stage of estrus and then implant them.

In this case, these animals were born at Colorado State University 2 years ago, the very first ones born in this country.

Since that time, within the last month, horses have also been produced using this kind of cloning technique, and they are genetically identical in every sense, and it's now being done routinely in the cattle industry, and it's beginning to make its way into the horse industry.

The opportunities for cloning allow us, as livestock breeders and so on, to rapidly increase the genetic pools to provide a larger number of possible pregnancies from a donor cow that does not respond well to superovulation, the technique that I showed you the last time I was before you, Mr. Chairman.

It also allows the transfer of one-half of an embryo while storing the other half, until you see the product that you have and decide whether that's what you want or not.

You can decrease the number of donor cows needed for transfer; you can reduce the average cost of pregnancies; overall, you can increase the gain from a specific genetic mating.

America is the leader in this area, but last week, Mr. Chairman, I suppose both you and all the members of your subcommittee are aware that the European Economic Community addressed a proposal to invest $134 million over 5-year timeframe in biotechnology.

Mr. Chairman, they call that a common market in biotechnology, so others around the world recognize the significance of this effort.

A second example is one that has been in the news a lot, the ice-nucleating gene storing. This one comes from the State of California.

Much of the frost damage in plants is caused by an organism, pseudomonosyringi by name, and it has a chemical within it that helps form ice crystals at temperatures of 32, 33, 34 degrees Fahrenheit.

The particular organism in question—we have learned enough about it in the laboratory to be able to excise, or cut out of the gene, that part that is responsible for producing the chemical that provides the nucleus around which ice crystals form.

When you pull that out, you can now replace the more common ice-nucleating psuedomonosyringi organism with its brethren that doesn't contain that capacity, and when you do it, it can survive temperatures of up to 9 degrees Fahrenheit lower for a prolonged period of time than it can with the more populous syrngi species, and this particular picture shows plants.

[Picture shown.]

Mr. **Jordan**. The one on the far right has been—these are potato plants. The one on the far right has been sprayed with the de-ice-nucleated variety of pseudomonosyringi, and the one on the left has the fairly common—very common organism on it, and they are both exposed to temperatures of about 25/26 degrees Fahrenheit for a prolonged period of time.

You can see the one on the right is hardly damaged at all, and the one on the left is just not going to produce any fruit at all.

What this would mean for America, Mr. Chairman, is perhaps $1 billion a year in crop savings.

Mr. **Brown**. Dr. Jordan, I certainly hope you are doing that with citrus as well as potatoes.

Mr. **Jordan**. Well, we are, and we are doing it with a number of other products. In fact, in front of you, sir, these have been flown in from your State late last night, and they are strawberry plants.

[Plants shown.]

Mr. **Jordan**. The one on the right, again, is what the plant looks like when it is sprayed with the very normal or natural form of pseudomonosyringi that does not contain this ice-nucleating gene, and the one on the left has the normal ice-nucleating gene, pseudomonosyringi, on it, the one that is more common in nature, and they have both been exposed, again, for a fairly short period of time to temperatures in the low 20s.

The one on the left is in the process of dropping its leaves, turning to a dark color, and literally dying on the vine. The one on the right is doing quite well.

Mr. **Brown**. Did you have to get court permission to bring those in here?

Mr. **Jordan**. The truth of the matter is, sir, we don't have a genetically engineered compound on the one on the left. It is a natural brethren, but it is not very much available in nature, because it doesn't survive as well, and so it has to be cultured in the laboratory.

But the direct answer to your question, sir, is that it has been cleared by APHIS before it was brought here.

Mr. **Brown**. OK.

Mr. **Jordan**. The recombinant DNA or gene-splicing techniques were initially found of practical use in the manufacture of pharmaceutical products like insulin and human growth hormone, but agriculture can certainly build on these technologies.

With genetic engineering, plants may be able to provide not only more nutrition but repel insect pests or survive salty water. Engineered microbes may someday help weak plants provide their own nitrogen from the soil or combat specific diseases.

You know the story about Mr. Sirica's preliminary injunction, and I will not go into that unless you have questions, Mr. Chairman, but I would like to go on to the third point, namely the issue of investment in the development of the human capital for use in the agricultural system, particularly with respect to research extension and teaching needs for the future.

The data here are irrefutable. There is a net loss of 15 percent between those joining agriculture and those leaving agriculture in the professional ranks today, the latter due, or at least exacerbated, by the retirements of large numbers of people.

The record reflects, however, Mr. Chairman, that the system of 86 institutions that CSRS participates in provides nearly 13,000 graduate students with at least partial funding. Of those, three-quarters are students studying at the master's level and one-quarter at the doctoral level.

Students at the master's level may progress to the doctoral level, but approximately two-thirds of them go on to be professional laboratory technicians, high school teachers of science, or work in the agricultural industry.

Support for graduate students through CSRS and the State agricultural experiment station system, however, provides funding only for students to do research and does not provide funds for teaching experience or teaching fellowships.

On the other hand, they do provide funding for a reservoir of people who can, with proper additional training, become teachers in the college and university system.

CSRS is a strong supporter of the higher education program with the Department of Agriculture and will do everything it can to assist in the coordination and strengthening of the reservoir of human capital available to conduct agricultural research, extension, and teaching activities, and also to provide well trained individuals for the agricultural industry.

Mr. Chairman, I and my colleague, Dr. E.L. Kendrick, Administrator of the Office of Grants and Program Systems, will, of course, be pleased to respond to questions at the appropriate time.

[The prepared statement of Mr. Jordan appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you, Dr. Jordan.

Mr. **Bentley**. Dr. Jordan indicated that Dr. Kendrick was here. He is on my left, your right. I want to be sure that he is recognized.

Also at this time, it is probably appropriate to point out that Dr. Joe Howard—on my right, your left, who directs the National Agricultural Library, is here but will not be making a presentation.

Two people in the audience I would like to introduce—Dr. Bruce Cone, a Deputy with me in my office, should be right in back of me; and I think it is appropriate here when we are talking about the needs assessment—Dr. Paul O'Connell from the Forest Service headed up the group that did a lot of work on this report is here this morning. He did much of the writing on the reports. He will be working with me also in the development of the statement for the policy group—Mr. Lyng and the group within the Department. Dr. Paul O'Connell.

I'd like now to move to the next presentation from Dr. Mary Nell Greenwood, the Administrator of the Extension Service. She has been before this group before, and I am sure many of you know her, and I am pleased to present her at this time.

Mr. **Brown**. We certainly welcome Dr. Greenwood again.

STATEMENT OF MARY NELL GREENWOOD, ADMINISTRATOR, EXTENSION SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Ms. **Greenwood**. Thank you, Mr. Chairman, Mr. Roberts, Mr. Olin.

I appreciate the opportunity to appear before your subcommittee. Your hearings have given the Extension community an opportunity to demonstrate the historic effectiveness of the Cooperative Extension System as well as opportunities in the future.

I have submitted a statement for the record and will endeavor to condense my comments this morning.

Since the hearings on Cooperative Extension were initiated in March 1982, significant strides have been made in resolving issues associated with the system. These actions include the issuance of USDA/NASULGC committee report on "A Perspective for the Future of the Cooperative Extension Service." This is frequently referred to as the "Extension in the 80's" report. We conducted internal and external reviews of the Federal partner, resulting in a system wide consensus on the functions and future directions for the agency, described in our "Blueprint for the Future". We designed and implemented a new nationwide accountability and evaluation system for tracking our programs and we are strengthening needed interactions and linkages with USDA research, action, and regulatory agencies.

Mr. Chairman, at the June 1983 hearings of your committee, we discussed "extensively the Extension in the 80's" report and the blueprint, so I will not be addressing those, per se, in my comments this morning, except to indicate that the "Extension in the 80's" report did reaffirm the mission of the Cooperative Extension system to be that of disseminating and encouraging the application of research-generated knowledge and leadership techniques to improve American agriculture and to strengthen this Nation's families and communities.

As I indicated earlier, several initiatives discussed at previous hearings are now operational and, I believe, producing positive results. One of these is the new Accountability and Evaluation System which became operational in October 1983, and one of the issues you identified in the charter around which several questions were raised.

Key ingredients of our new system are: One, a 4-year planning cycle: two reduced and improved reporting procedures, and three, increased and more effective evaluation at both the State and national levels.

The 4-year programs of work in each State focus on major program efforts, including objectives and projected impacts for each major program.

The planning process actively involves citizens across this country in identifying and prioritizing needs, and then major programs were developed to address those needs.

Another key ingredient of the system is expanded program evaluation. Working with our State and county partners through the National Extension Accountability and Evaluation Policy Council, we have identified and implemented national evaluation studies focusing on five program areas. In addition, my colleagues across the country are initiating more than 200 program evaluation studies. A number of these are multistate in scope.

The national studies currently underway focus upon integrated pest management, renewable natural resources, financial planning and management, volunteerism, and leadership development.

These studies, are designed to measure social, economic, and environmental impacts, and will provide valuable information on program participation, program management practices, the effectiveness of different program delivery mechanisms, and linkages among research, extension, and action and regulatory agencies.

We believe the information that will come from these studies and others that will follow in the future will provide extension administrators nationwide with valuable information for improving both the effectiveness and efficiency of our programs, as well as identify areas where policy changes may be warranted.

The accountability and evaluation system is now on line and a source of information about major programs in each State with reports of accomplishment, and evaluation studies accessible to all three partners through our national communication network.

This system will provide all partners of the Cooperative Extension System with what I believe to be the single most powerful management tool that we ever had for the system.

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In your charter, questions were also raised relative to the relationship between 1890 and 1862 institutions. Sixteen States have both 1890 and 1862 institutions that are involved in the conduct of Cooperative Extension programming.

In accord with the Food and Agricultural Act of 1981, the respective institutions in each of these States maintain comprehensive and integrated program plans which were updated in 1983. Representatives from these institutions collaborate and jointly submit 4-year program plans of work to USDA.

The development of both the comprehensive and 4-year program plans provide viable mechanisms for coordination and cooperation in the delivery of extension programs and help assure effective utilization of resources in each of these 16 States.

The recently completed needs assessment on the Food and Agricultural Sciences provides guidance in identifying national extension program priorities.

The Extension system has made significant efforts over the last decade to target and redirect programs, and in accord with the needs assessment and the extension in the 1980's, the 4-year programs plans of work address high priority issues as identified in those referenced documents.

These high-priority program areas include crop and animal production efficiency, financial and marketing management, human nutrition, leadership development, as well as others.

Among the areas receiving increased emphasis during the next 4 years, as identified by my colleagues across the country, are soil and water conservation, forest and rangeland management, processing, marketing, and distribution, as well as agricultural and natural resource policy.

I would like to comment briefly upon interface between extension, research, and action and regulatory agencies. The importance of translating revolutionary scientific research to enhance agricultural and new productivity in this country dictates an even stronger collaboration between research and extension.

Extension programs, if they are to be effective, depend upon an adequate base of research-generated knowledge. Powerful linkages exist within our cooperating institutions, between research and extension specialists across the country.

We are aggressively pursuing stronger linkages with federally supported research laboratories, and my testimony identifies illustrations of that. We are also continuing to explore other possibilities for interaction with others.

The cooperative extension system also serves as an important conduit for Federal and State action and regulatory agencies in educational programming with producers, consumers, and local and community leaders.

Here again, we could cite numerous examples of cooperative effort. An illustration is our current effort with the USDA Food Safety and Inspection Service, helping livestock and poultry producers avoid drug and chemical residues in slaughtered animals.

We also have cooperative efforts with the Federal Crop Insurance Corporation, Farmers Home Administration and other agencies within the department.

We are also implementing shared positions with other agencies where either expertise or liaison is needed in critical program areas, such as conservation tillage and rangeland management.

As we continue to respond to the recommendations as contained in the extension in the 1980's report, the "Joint Council Needs Assessment," findings from this subcommittee, and views expressed by user and advisory groups at all levels. We, in extension will endeavor to initiate program and administrative improvements to stay on the cutting edge.

Mr. Chairman, it is my expectation that in the coming months and in concert with my Federal and State colleagues, to implement additional improvements in our current operations.

One of these is to continue pursuits to capitalize and utilize existing and new electronic technologies in the delivery of extension programs. I have not included this in my testimony as it was addressed yesterday by Dr. Henry Wadsworth, the Chair of ECOP and the director of extension at Purdue University.

We expect to institute improved systemwide processes for identifying and supporting national and regional program innovations, including emerging technologies, and also to develop and refine an efficient and timely process for identifying critical national and regional programmatic issues.

The extension system has been very effective at the State and local level in needs identification. In my judgment, we can improve that process at the regional and national level.

In closing, as we continue to move forward in our efforts to strengthen the cooperative extension system so it will continue to be a vital force across this Nation, we must be mindful of those characteristics of the system that have allowed it to be a unique achievement in American education.

Some of these characteristics include the tripartite partnership, the involvement of people in our planning processes, adequate flexibility for programs to respond to changing conditions, research-based information system, and our ability to work effectively with the private sector, and our nationwide system of adult and volunteer leaders that help in the delivery of programs under the direction of our professional staff.

On behalf of my colleagues across the country, thank you for the opportunity to participate in your hearings. I look forward to responding to any questions that you may have.

[The prepared statement of Ms. Greenwood appears at the conclusion of the hearing.]

Mr. Brown. Thank you, Dr. Greenwood.

Dr. Bentley.

Mr. Bentley. I would now like to turn to a presentation from Dr. Keith Shea from the Forest Service.

Before I do, I would like to mention that in the deliberations of the Joint Council, there is involvement of the representatives from both the Economic Research Service, Dr. Lee, and from the Forest Service, Dr. Bob Buckman.

This involvement is not just participation, but it is an active one. In fact, Dr. Buckman led the major planning effort in terms of the internal committee within the Joint Council in the development of these four reports that I referred to earlier.

So while the Forest Service is not a part of the science and education agencies, there is a great deal of communication and participation in planning activities that relate to research in education.

There is a considerable amount of it with regard to ERS now, and I mentioned that Dr. Taylor will be working with us on the staff, along with Dr. Miller and others, and that through this way we think we are accomplishing a great deal of interagency communication, and this morning the presentation from Dr. Shea will, I think, substantiate that statement.

Mr. **Brown**. Before Dr. Shea begins, may I just insert at this point a word of thanks for the assistance that we have received from a number of people in the Department temporarily assigned to this subcommittee to help us with past hearings, but the current one is from the Office of Budget and Program Analysis, Mr. Kennan Garvey, and he has been extremely helpful in organizing these hearings, and we want to recognize that. Hopefully, that will filter back to his office in some fashion.

STATEMENT OF KEITH R. SHEA, ASSOCIATE DEPUTY CHIEF FOR RESEARCH, FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. **Shea**. Thank you very much, Dr. Bentley.

Mr. Chairman and members of the committee, it is a pleasure for me to join with my departmental colleagues here today in presenting testimony before you.

As Dr. Bentley mentioned, the Forest Service is an active participant in the joint council activities, and we also participate in the efforts directed by the Assistant Secretary for Science and Education.

We believe that forestry and related renewable natural resources have been well served by the long-term nature of this science and education partnership.

With your permission, Mr. Chairman, I will attempt to highlight my remarks and provide the written statement for the record.

Mr. **Brown**. Without objection.

Mr. **Shea**. Let me begin by noting, first of all, that forestry is big business in the United States. The total forest and land base in this country is about 750 million acres, or about one-third of the total land area of the country. Of this, about two-thirds, or 480 million acres, can be classed as commercial forest land.

The forest products industry adds about $62 billion a year to the U.S. economy and represents about 7.5 percent of the total value added in all of the Nation's annual manufacturing activities. Thus, about $1 out of every $13 of manufactured value added comes from the forest products industry.

About 1 of every 11 jobs in the Nation in one way or another is associated with the forest products and forestry.

Additionally, the Nation's forests of course are important for grazing, for recreation, for soil and watershed protection, as habitat for wildlife, and certainly as a major source of water for many of the Nation's cities and farmlands.

The forestry research that is conducted and supported by the Forest Service in fiscal year 1984 amounts to about $108 million.

The 61 forestry schools in the Nation have a research budget approaching $80 million from all sources combined.

These two programs—that of the Forest Service and of the 61 forestry schools—account for the vast bulk of publicly supported forestry research in the United States. Thus, I think you would agree that it is very important that these two programs be closely coordinated and integrated.

Such efforts in coordination and integration include, first of all, forest research planning. The forestry schools and the Forest Service have taken a number of steps to integrate their research activities dating back for several years.

The most recent product is one that I have here, the 1980–90 National Program of Research for Forests and Associated Rangelands.

[Publication shown.]

Mr. **Shea**. The next joint planning effort is already under way and should be completed early in 1985.

In addition to these national planning efforts, more detailed regional and local collaboration and coordination are done through the four regional planning groups. These planning areas coincide with those used by all the other science and education groups in the Department of Agriculture.

Another area of considerable interest and concern is research evaluation. About 5 years ago, the Forest Service and again the forestry schools looked at the need for better evaluation of research.

The aim of that joint effort was to improve priority setting and to evaluate the outcome of a variety of research programs. The result of this study was the "Criteria for Deciding About Forestry Research Programs," and it has been very useful in establishing research priorities.

In addition, the Forest Service and the forestry schools, with the Cooperative State Research Service, have undertaken a series of rather specific studies on what have been and what are likely to be the payoffs from forestry research.

Basic research, of course, has been mentioned here this morning. It is another example of joint planning in the forestry community.

The forestry sciences are concerned about the need to understand basic processes, as are other sciences in agriculture. Here again, we joined with the forestry schools and examined the basic research needs in forestry and published "Our Natural Resources: Basic Research Needs in Forestry and Renewable Natural Resources in 1982." I have a copy here with me.

[Publication shown.]

Mr. **Shea**. Since then, the Forest Service has directed approximately $1 million into various biotechnology research projects, and we intend to place more emphasis in these promising areas in the future.

Concerning regional and national reviews of research, the forestry schools and the Forest Service have embarked on a series of reviews of important science and education activities related to forestry.

One of these concerns is the utilization of forest products. This review is conducted under the principal leadership of the National Forest Products Association, representing the forest industries.

Other cooperative research reviews include a review of the national forest inventory, which is a periodic assessment of the conditions of forest lands of the Nation and a review to integrate and coordinate growth and yield forecasting, which is very important to public and private forestry, especially in the South.

Mr. Chairman, the Joint Council on Food and Agricultural Sciences has identified forestry research as one of its high priorities for examination. The Joint Council recognizes that there are a number of opportunities in forestry research that need additional attention.

In my written testimony, I have mentioned a number of these opportunity areas that have been identified, and I will comment on three of them this morning.

One which is of major concern is the area of basic research and biotechnology. Forestry will probably reap the largest return of any crop from the application of biotechnology, first of all, because there is so much potential improvement awaiting our discovery, and, second, because tissue culture and gene-splicing technologies offer a way to shorten the period between generations of forest trees, which now may run as high as 15, 20, 25 years.

Another area that I would like to just mention briefly is the international activities. These have been identified also by the Joint Council as an area of potential opportunity.

North America and the United States have the productive capacity to be really the woodbasket of the world. To realize that capacity will require development of technologies so as to lower cost of products and increase demand on world markets. This also will entail development of technologies to use efficiently a vast reservoir of underutilized hardwoods growing in the United States, principally in the Eastern part of the country.

In addition, in the international area, training and technical exchanges with other countries make it possible to share experiences and data, to exchange germ plasm, and otherwise share information that can improve the efficiency of forest production.

Last, I would just like to make a comment regarding resources and funding availability.

As I mentioned, Mr. Chairman and members of the subcommittee, the next round of research planning by the forestry schools and Forest Service will be completed early in 1985. At that time, we will be prepared to go into still more detail about the opportunities and needs associated with publicly supported forestry research in this country.

The several points brought out in the Joint Council discussions about forestry research might also serve as a basis for review by this committee or by others.

I might mention in closing that the planning and coordination in forestry research is closely tied to the Joint Council's long-term needs assessment, to the 5-year plan, and the annual priorities.

Mr. Chairman, this concludes my testimony, and I will be happy to respond to subcommittee questions. Thank you.

[The prepared statement of Mr. Shea appears at the conclusion of the hearing.]

Mr. **Brown**. Thank you, Dr. Shea.

Dr. Bentley.

Mr. Bentley. This does conclude the presentation of formal statements this morning. There are other statements that have been submitted for the record.

Three things came to mind as I was sitting here listening to the four presentations that might be stressed a bit.

One is in Dr. Kinney's remarks, I think it appears in his written testimony—but there is one thing that I believe this committee would be interested in knowing. It is the stress that the ARS is placing on communications and providing service to the regulatory and action agencies in the Department. He is placing staff members from the Agricultural Research Service with these agencies, or wherever they are needed to facilitate planning activities. And while this is maybe recorded by Dr. Kinney as somewhat of a regular activity—I think it is of interest to point out this development.

In the area of higher education, activities started in January with a secretary's sponsored challenge forum held at the National Academy of Sciences—it involved the representation from industry and participation by the National Academy through the National Research Council.

That started a series of discussions that are ongoing concerning the need for more trained people, and getting more interest in developing a broader base for drawing students into agriculture at our universities, community colleges, or wherever.

That was two activities that followed along at the AAAS meetings in New York. There was a session devoted to human expertise. At the Governors' Conference on Technology, one of the leadoff panels had to do with the human expertise needs for agriculture.

The other point I would like to mention is that on the needs assessment report distribution, we have not only circulated copies to the members and people that are interested in the matter of planning—literally thousands of copies have gone out—Dr. Miller, Dr. Tim Blosser, are working with this as staff for the Joint Council. A slide set series has been developed, about 13 minutes long, that highlights the needs assessment; and efforts have been made through the staff to get copies of that to the deans of agriculture, to the representatives from the home economics, veterinarian medicine, forestry groups, so that we have a summary and we are encouraging people to use that.

I think that is being used and we think that is part of our responsibility to get the information out. I just wanted to highlight these. All of these comments appear in the testimonies, and the proper ones, but it seemed to me it was appropriate to make reference to it.

Thank you. We would be pleased to answer questions.

[Siren.]

Mr. Brown. Thank you, Dr. Bentley. The siren is just a practice, nothing to worry about.

Mr. Roberts, do you care to ask any questions?

Mr. Roberts. Yes, I would, Mr. Chairman.

The thought occurred to me that if that siren were for real, all of us would be etched in stone as being present and accounted for trying to solve the problems of agricultural research, and whatever.

Mr. Chairman, I would like to commend you once again for holding these series of hearings and your leadership in this regard. I want to associate myself with your remarks, more especially in regard to the micro and macro factors that are affecting agriculture, extension agriculture, research, and more especially the producer in my district—I want to thank you on behalf of my producers.

This, I think, Mr. Chairman, is sort of a record turnout here, that we have had before the subcommittee. It is quite a hearing, I have enjoyed it very much. I want to thank all present for your very fine testimony and your comprehensive statements. I think it is a little bit like Cecil B. de Brown's agriculture research presentation. [Laughter.]

We have 7 doctors with over 250 years of expertise and training and education at 1 table; 50 to 75 assistants who have to be qualified as the powers behind the research throne; I don't know how many pamphlets, four major reports, two cloned calves, two strawberry plants; and if Dr. Jordan had anything to do with it, I am sure he could get at least two partridges in any pear tree that he would want. [Laughter.]

You have rounded up, Mr. Chairman, and captured more education expertise and 35-cent words and advice, I think, than anybody has ever done in any subcommittee. That is to your credit.

I think I would sum it up in the words of my 5-year-old, when I would simply say, "awesome". And according to that ad, if you continue the tag line is major motion, and I would hope we could achieve some major motion as a result of all this fine testimony.

Dr. Bentley, we now have four reports, a long term needed assessment, a 5-year plan, the annual priorities report, and annual accomplishment report, all of which are very much interrelated.

I know, and I share, your support in regard to the need for developing these reports, but I would like to have your candid observations if they will prove useful in the short term in regard to the price and cash flow, and the credit crunch we are in in farm country. And in light of your comments, would you assess it from the standpoint of the uncertainties that face us in regard to population growth—first we get it one way, then we get it the other, in terms of the trends—income growth, of which we don't have any in farm country; and competitive trade patterns. I just heard over the news as I came to work this morning, that the International Trade Commission, by a 3 to 2 vote, has decided that steel imports do represent a threat to our domestic industry and we are going to put some quotas on—and that affects Japan, and that affects wheat exports; and here we go again with what I perceive as protectionism. The ugly head of protectionism seems to rear its head here every election year.

How do we make these reports useful over the short term to the producer, given the uncertainties that have happened in agriculture. And I am talking about the chairman's comments in regard to macro effects, embargos, trade sanctions, weather, PIK, and all of these things. That is a tough, tough question, and I have been too general in it, sir, but I feel that you are fully capable of answering. [Laughter.]

Mr. BENTLEY. Thank you.

Mr. **Roberts**. How do I explain that to my producer?

Mr. **Bentley**. This is a serious set of questions and there are implications, of course, well beyond science and education in each of the comments you make, but it is still a part of it.

To start with, I think I said in my testimony that the real test of what benefits come from the Joint Council activities is how well the system—and I speak here about the State system, the Federal partners, and the private industry—use the recommendations in making both short- and long-term decisions about directions for science, for the technology development.

We think there are some good signs that recommendations developed from a broad base of people involved—the experiment station, extension, teaching programs and Federal agencies—are being used to set program directions.

We talked with and involved the agencies in developing the plans. I suppose if I would look at it from my point of view, I could phrase my position at the moment by saying these are the recommendations you gave to us as the Joint Council, now the next year, so we have to see what you are going to do about it because you said these are the—you, I use the word collectively here—said these are the priorities, so we should start looking in this direction.

Now, when we talk about income growths and competition, and in agricultural products, because there is an area of a great deal of difference of opinion. But from what I have observed over the years, while the sorting out may be difficult, and the transition from one kind of activity to another, is that it causes trauma.

I experienced that in the Great Plains when I grew up from the drought years in South Dakota. I saw trauma that was pretty apparent when you go to the little country church, you knew what that was when families were packing up what they had to go West or go South, or go someplace, out of that particular area. So I know what this is about from a personal point of view.

But the other thing is that the matter of the success of an industry, it seems to me, we have to increasingly look at our real competitive strength. Can we produce a product that is of the quality that we need and use the amount of resources so that we are competitive on internal markets and worldwide markets? And that is part of what we are going through.

We hear different views on this question—and I guess I share with you the concern about protectionism, because I think we went through one of those cycles about 20 to 30 years ago, 40 years ago; and that didn't work out very well. So I think that we have to keep this in mind, but that is a political aside, not as a scientist. That is my own personal reaction.

If we are going to make these kind of changes, it seems to me we need to have the very best science and technology that we have. And increasingly we see countries that are making decisions that could be competitors, or buyers of our product, that are looking at this matter of saying that they are going to apply the new biotechnology to make the products, tailor products, to make them more effective and so forth, and make them more cost effective in terms of production.

So in the short term, these applications may not be useful in answering some of the questions that have developed over the past few years in the farm community. On the other hand, it may be very important to the future of it. Many people feel that that is important, that that will be very important, and we think national planning efforts will make important contributions.

I think that the agricultural experiment stations, the industry, our Extension Service, and our Federal agencies will have to move aggressively to get new answers to some of the problems that we have, so that production costs can be cut.

There is another area I believe we can address that is very important that deals with this, is the whole matter of our environmental effects whether we talk about the soil conservation programs, conserving soil, or in handling some of our chemicals used in production agriculture safely and don't create water quality problems, food safety problems, and so forth. I think we can contribute here and that leads to stronger competitive positions.

As regard to uncertainties, that is, of course, a part of our agricultural problems. On the other hand, I must say that over the years, the research programs that have been conducted that they deal with—and plant breeding, for example, has certainly enhanced the capacity of plants to deal with such stress as drought and so forth, which is part of the uncertainty question.

As I recall, when I was in South Dakota, that in this southeastern part of the State, there was a period of time that the rainfall pattern was not too different from some of the drought years of the 1930's when they had absolutely no crops, and whereas at that time, there was still a reasonably good crop produced even under these stress conditions, and that had to do with the capacity of plants to react.

I have not answered your question in detail and specifically.

Mr. ROBERTS. I am not sure that you can answer it.

Mr. BENTLEY. But I think we can contribute to it, and I believe our people are sensitive to these concerns.

Mr. ROBERTS. I am being the devil's advocate here; you are making an outstanding contribution. You are giving us options with which it is our responsibility to go forth with these options. I am not too worried about our producers. They are in a situation where their very survival depends on some of your research.

I am not really too worried about industry, because I think industry is going to pay attention. If they don't, they won't make a profit, and they won't stay in business.

Now, I am really not too worried about my chairman and my colleagues on this subcommittee. We tend to be very parochial—if we don't take care of our districts, I don't think anybody else will, and we know the value of ag research.

What I am worried about are those folks who sit on the domestic council and make these policy decisions where we seem to end up in a ditch all the time, and I am wondering if there is some way we can bring these collective reports and wisdom, and expertise, and options, if you will, to the attention of those people.

I don't worry so much about what we do, as what we don't do. We have some very fine people here who can show us that we have been down this road before—it does not pay out. And I don't care whether you are talking about trade or an investment, in ag research, or more moneys for biotech. I was not aware that the European Common Market had now designated, $172 million, or what is it?

Mr. JORDAN. 134.

Mr. ROBERTS. All right. Now, if we are going to compete in that area, and you know, we are going to have the kind of markets that we have to have, and the kind of product, we are going to have to make that investment.

The chairman made a very noble effort on the floor of the House. But during these budget considerations, we have some problems that way.

Can you think of a vehicle, a policymaking vehicle? There is an effort in my State for sort of a Federal Reserve Board of Agriculture, if you will. I am really not for that, but at least when we are making these decisions on a policy standpoint, we should have somebody that says, stop, wait a minute, let's consider these kind of things—whether it be soil conservation, or whatever.

From an administrative standpoint, do you have any advice there? I know that is asking you to tread on thin ice.

Mr. BENTLEY. No; I would be pleased to answer that but in a very limited way, and perhaps in what is a too conservative way.

Yes, I have a great deal of confidence in talking in two or three areas. One is that within the scientific apparatus of this country—I am talking about the Academy and the National Research Council, OSTP—I think there is a growing appreciation of the role of agricultural science and the importance of agricultural sciences to the competitiveness of the agricultural industry. That has been there all the time, I don't mean it is new. But I think there are renewed efforts here. I believe that we have used discussion of biotechnology to do it, but I believe that our administration—the Secretary and others of us—have talked to these people. We have gotten some new appreciation, not a new thing, but we have made progress there.

The other area is that I believe agriculture itself has an opportunity to relate the dynamics and wellness of its industry to the science and education part. We have done that in the past and a great deal.

I was heartened, for example, to notice that the New York Times recently had a front page article talking about the changes and directions of the research taking at Beltsville, and saying here is something that they thought would contribute to it.

So we have got to get it to the general public and a little broader understanding of the area.

I suppose I am reflecting a bias here, the concerns over markets and trade, and so forth, are kind of headline issues every day. Whereas, talking about science, for example, these cloned calves from Colorado might be gee whiz-type things but it doesn't really seem to relate in the minds of people that that is the technology.

Mr. ROBERTS. Well, it should, and that is the whole point.

Mr. BENTLEY. That is what I think we have to do a harder job on.

Mr. ROBERTS. See—that is the payoff down the road. We are so reactionary here, we are a frontburner town, and you are talking about things on the backburner that will be frontburner and will affect that cost price squeeze that we are going through, but we can't seem to recognize that.

Mr. BENTLEY. That is why I think, if I may add to that, that I was pleased that there would be an opportunity, at least in the administrative side, to bring the concerns of science into the early discussions, at least, on the administration's consideration for the 1985 farm bill. I think that is an important thing.

How far this goes, I don't know, but I start everything with an optimistic attitude.

Mr. ROBERTS. We will try to tote the bucket as far as we can and sincerely hope that it doesn't have any holes in it.

Dr. Jordan, you say a net loss of 15 percent of people that we need in the professional ranks, on page 7 of your statement. Yesterday, in trying to pull teeth from a witness, I tried to head down the road that we need to get more support from industry, to let people who graduate and see a profit potential in one pasture, to go into industry, but then come in through the back door and continue their education, if you will.

Is that a viable, say, alternative, or am I just hoping for things that aren't going to happen?

Mr. JORDAN. No; I think it is not only viable, I think what we really have to say is that there are many access doors to knowledge, and it is knowledge that we are really about, not degrees and not anything else particularly, but knowledge, per se, and there are several routes to it.

I think the knowledgeable farmer and rancher, and the information delivered to that person, is the key that makes America the envy of the world in food fiber and forest productivity.

Mr. ROBERTS. Dr. Greenwood, we had some witnesses here several days ago who predicted a golden age for agriculture, that hopefully some of these macro kind of effects will even out, and that all of the things that have been going wrong can't continue to go wrong, unless you believe in Murphy's law—and my producers are about ready to believe in that, and I hope they don't call it Roberts law. [Laughter.]

At any rate, one segment of that golden age is computer technology, and I have a series of questions I would like to ask you, and I will try to make them brief.

Is computer technology being accepted by the producer in your experience with Extension? And if no, why not?

Ms. GREENWOOD. In response to your question, I will make some comments and then my associate administrator, Dencil Clegg, who cochairs an ES ECOP committee looking at the whole matter of electronic technology is here.

Mr. ROBERTS. Yes.

Ms. GREENWOOD. We do find producers accepting computers and their use; we find a great interest on the part of producers in trying to learn more about how they to use them.

The whole area of electronic technology has tremendous potential in aiding us in the transmission of information and can help us modernize our system.

With those brief comments, Mr. Clegg, are you ready to respond?

Mr. CLEGG. Yes; we have had a series of study groups at work. One is a report that was produced in 1982. This report is our reference point. Another group studying this issue right now.

In terms of adoption, Paul Yarborough at Cornell University, has studies under way both in Iowa and New York. It is a linear type of research and he is finding similar rates of adoption in both States. We probably ought to have some work in the South and maybe the West. But usage is correlated very much with education, income, use of computers—off the farm in their educational effort in schools and colleges and their level of management expertise.

These studies would indicate by the year 1990, perhaps, 85 percent of the farmers would be adopting this technology.

Mr. ROBERTS. Yes.

Mr. CLEGG. The guidance to extension—the guidance to the research community—you have a little time, you need to get your act together because people are using electronic technology.

Mr. ROBERTS. We had a witness yesterday that indicated with 40 subscribers his main problem was the software that was available to that farm family.

I guess my next question would be, is Extension called upon for advice as to what software packages are appropriate?

Mr. CLEGG. Yes; very much so.

Mr. ROBERTS. OK, do you have the necessary expertise in the computer field, do you feel, out in the field, say, with your people?

Let me indicate where I am headed. We have the CFTC now going out in the field—with a good friend of mine named Heinemann who happens to be a Commissioner on the CFTC. He says that ag options are the way that many farmers can hedge in this kind of a market that we are experiencing. There is a lot of opposition to that.

Personally, I think if more producers had the software packages and understood it fully, as you say, in terms of education, income, so on and so forth, they could be on the crest of a wave of at least that will keep them in business until this golden age occurs, whenever that happens.

Are you up to speed with that kind of a need?

Mr. CLEGG. I think there are institutions that are up to speed; in fact, in the leadership role in this area, working with the private sector as well as with the research community and their colleagues across the country.

We have the Computer Institute in Wisconsin in the north-central region, a brandnew institute in the Northeast at Penn State. The southern region has a coordinating effort underway working among the institutions; in the West a number of States now have a computer in each of the counties. A year ago, I think we had microprocessors in three or four States. Today at least 15 States have this equipment in each county.

We have a survey under way—Florida which should be completed shortly which will be a summary of the kinds of computer software you are talking about. Some of the software probably needs to be evaluated, indexed, documented, and will be out of date shortly. But there is a lot of activity, we just need to coordinate some of our efforts better and improve communication among institutions.

Mr. ROBERTS. Let me be the devil's advocate again—and pardon me for interrupting—but should extension be involved in this or should this be left to the private sector? Are you in a competitive field here with the private sector in regards to sharing this information?

Mr. Clegg. I would say in a cooperative effort, very much so.

Mr. Roberts. That was the proper answer, by the way. [Laughter.]

You have talked about Florida and you have talked about Wisconsin and various States. Is each State really headed on its own program or is there a guidance from a national level as to how we can get this all coordinated?

Mr. Clegg. There is some guidance. I think there is a tremendous amount of coordination and communication. That is why these institutes were established, is to provide some mechanisms for the avoidance of duplication, and to strengthen the overall effort.

Ms. Greenwood. There is an opportunity for improvement in that area. That is one of the things that this task force is looking at—increased mechanisms and ways in which we can increase collaboration across State lines, et cetera.

Mr. Roberts. Let the record show, Mr. Chairman, that I am extremely interested in this topic and I have asked some questions that I think the subcommittee has already had the advantage of excellent testimony.

But yesterday we had a question of whether there was competition with a local computer information service in the State of Maryland through the extension department and then also whether there was competition with a national service.

I view it much in the same fashion, being an old newspaperman, I view it much in the same fashion as your networks, and your local radio station, your daily newspapers, your national newspapers, and there is always a need for that local daily newspaper, or say weekly newspaper. And they can pertain to, say, in my country, the High Plains, and the special needs that we have, and the Extension office is there.

I credit you with being the primary moving force behind this, and I would hope that we could do this with the private sector in a cooperative effort. If there is anything that is really going to enable the producers in my country to at least hang on and stay in business, to benefit from this golden age of agriculture and all of this research that you are talking about, it is education. And I foresee that this is the method that it is going to get done, or it won't be done.

Thank you, Mr. Chairman.

Mr. Brown. If I may comment on that point, there is a very widespread concern about the quality and availability of software that goes far beyond this committee. There is actually legislation before two or three other committees of the Congress dealing with this software problem, and proposing standard setting, regulation, and a lot of things of that sort, which will impact on agriculture, obviously. But it indicates the rapidity with which this issue has become a fairly substantial priority in many areas of our society.

I think agriculture has the opportunity to be in a leading role here primarily because of the close links that exist between the research community and the user community through the extension system.

I would suggest that this is something that is worthy of close study by the agricultural system and can help to set the standards for other sectors in the economy as well.

Mr. Olin.

Mr. **Olin**. Thank you, Mr. Chairman. I just have questions in two areas.

Before I ask them, I would like to compliment the panel. The presentations were extremely interesting and constructive.

I just want to observe that over this series of hearings, I have not attended every minute of every one, but it seems to me that one of the main prevailing themes was from the educators and others that came here, that they were very worried about the fact that we are not attracting enough technical talent either to the colleges or graduating them, or they don't go on to graduate work sufficiently to meet the perceived needs of the agricultural segment of the economy.

That is, of course, surprising, in that the quality of the technical work going on is just as high-tech as anything you can imagine that some of it doesn't involve microcircuits but in the biotech area you probably have even more on the forefront of technology than even the semiconductor people are, the value is extremely high.

I am just wondering, Dr. Bentley, or anybody else that wants to comment, how do you assess the degree of seriousness of this problem of not enough talent coming along? Is it serious or do you think that the natural course of events of the values being produced will finally correct the problem before we find ourselves falling behind?

Then, what do you see your role in this problem, assuming you think it is a problem? Are you proposing to try to do something about it, or encourage us to do something about it?

Mr. **Bentley**. Thank you, Mr. Olin, for the question.

I guess I view the situation in this light perhaps a little differently than some, but I think it is a serious problem, but would add an important problem that needs the consideration. I don't think we take this as a crisis situation at the whole, the system is falling apart, that there aren't good people and, therefore, I can explain in part why the progress is being made—but we are seeing a trend here that bothers us.

Perhaps we are conditioned a bit by prior experiences when we, as administrators in universities, we always felt it was difficult to attract the kind of students we had into agriculture because of a number of things: traditional patterns of views, what agriculture is; the failure of our society as a whole; to see the agricultural sciences as a profession, say, uncomparable with other scientific activities.

But we need not bewail that what is past, what we should do is think about the future. So I think that, yes, it is a responsibility that we have, and that I take as one of the major concerns we have along with research and extension activities.

Now, what could be done? I made reference to the Secretary's challenge forum in which we discussed the research needs, and here we tried to bring in industry so that we renewed the interest, not necessarily start it, but renewed the interest and emphasized the importance of an initiative.

I think the next thing that educators will say is, that through our secondary school system, we are not doing the kind of job we should to attract the attention and potential and excitement about the many areas. For example, biological sciences as a whole is experiencing this dropoff in student numbers.

We must consider the impact of developments in more glamourous areas as computer technology. Look at the television and you can see what kind of a bombardment the young person would have each day of a career opportunity and excitement there is in connection with this. Yet, going back to some of the more traditional programs such as agriculture is probably not as easy to dramatize and get attention to it.

So we think we need to do more work to interest young people and tell them about careers in agriculture to young people. That is the reason we are behind an effort—the Secretary has initiated—called Ag in the classroom. The goal of this progrm is to familarize more young people with agriculturals' role in our economy and of its importance to our society. One avenue is to get more information about agriculture into curriculum materials at the elementary and secondary levels.

I notice the State of Iowa just announced that they felt that 80 percent of the schools in Iowa will have some reference to agricultural activities in the elementary and secondary programs of their schools.

If you get the student thinking about that as an opportunity, then they come to the career choice in terms of college, if that is the route they are going to, they will consider that as an area.

A few years ago, in the merit scholarship program, the statement that was made about career opportunities in this big book, if you have seen it—it tells about careers, that students can buy for some $10 or so, to help them in planning and their guidance and counseling.

The reference would be that the opportunities are in farming and ranching. I think that was the total statement about careers in agriculture.

Now, no one suggests by that that we want to downgrade the opportunities or careers in farming and ranching, but there is a whole series of other careers that don't seem to be related to the agricultural question, the whole matter of the food processing jobs that is related, the matter of regulation.

And when we talk about some of the questions that are coming up concerning biotechnology regulation, it requires a tremendous knowledge of science to come up with judgments here. We think we can do something there.

There is also a question that our society and country has to face, is that we, by traditional reasons or for a combination of developments, value various careers in different ways, apparently, in terms of salaries and so on. Traditionally, agriculture research salaries, agricultural teachers, extension workers, have not been paid the same kind of salaries that someone might do in what we consider—and we are biased, of course—careers that are comparable, and we think that that is going to change.

The interesting thing is that the biotechnology is changing that in universities more than anything that I have experienced in my career—and I was 25 years in that kind of work.

Mr. **Olin**. I must say, Dr. Bentley, that one, probably of all of them, gets corrected if the supply is very short and the value is perceived to be high, the salary question will disappear rather rapidly.

Mr. **Bentley**. It is beginning to happen, and I think that is fine. I think that will help in the career.

So there will be a combination of things that will take care of it. Then we have to attract more people, perhaps, that are in other areas of science We, in agriculture, have to reach out, and they have to reach out perhaps into these careers, and I think through those combination of events. I am an optimist.

Mr. **Olin**. I certainly would encourage you to show as much leadership as you can. You are very well positioned to help the States and others do the right kind of promotional activities here which will raise the general public concept of the value of this work.

I would like to ask one question of Dr. Shea. I didn't expect that he would be here today but since you are here, let me bend your ear.

I happen to be becoming rapidly more of an expert than I would like to be on forest management practices, having lots of forest in my district, and lots of people that don't like the management; that is, not the people, but the management plan and the way it is being carried out.

Then I keep reading about the problems that forests are having, and the most recently I guess we have heard that the forests are not growing as fast anymore, some sizable amount—I don't know what it is.

I would be interested in comments that you may have as to what work is going on in your activity with regard to this question of the broad health of the forests. And there is more on that in the Pacific management practices but they tend to go together.

Have we got, in your view, a crisis here we ought to be doing more about sooner?

Mr. **Shea**. Let me comment on that, I am pleased to have that question. I happen to, in addition to my duties as Associate Deputy Chief for Research, I also serve on the Interagency Task Force for the National Acid Precipitation Assessment Program, as one of the deputy joint cochairmen. I might say that Dr. Bentley is also one of the cochairs of that particular group.

Regarding the general decline that we read about in the newspapers in forests, work has gone forward—it is still in a preliminary way. But, looking at increment cores from trees and looking at our forest survey data from the Forest Service, the evidence suggests that there has been a decrease in the diameter growth of trees through the Piedmont plateau area and certain parts of the Northeastern United States.

At this point in time, it is very unclear as to cause-effect relationships. Whether this is due to atmospheric pollutants such as SO_2 or the nitrogen oxides from internal combustion engines, from lead, or what, there is a great deal of uncertainty both here and abroad.

Then confounding those sorts of things, the atmospheric pollutants there are of course the questions of drought, sudden depressions in temperature, insects, diseases, and so on. At this point in time, I think it is very unclear as to a particular cause of what is an apparent decline. And from further analysis of the data, should this decline be substantiated, why, I guess I would feel in all probability we will find multiple causes, that there will be several things interacting together that can have an effect on the forest.

Now, as part of the National Acid Precipitation Assessment Program we, along with several other agencies, are heavily involved in studies of terrestrial effects on forests and in particular on crops and watersheds. In the President's 1985 budget, there is somewhat over $9 million proposed for additional research in this area. Currently, I believe the figure is around $4.4 million that is being expended in fiscal year 1984.

Mr. Olin. Could you speed up getting the better technical answers to this problem if you had more resources?

Mr. Shea. Of course, our research people always tell us they could use more resources. Some of the activities, I think, could be speeded up. Like many of the biological phenomena, though, it is a matter of time. One has to pass through a certain period of time in order to arrive at rather definitive answers. But most research endeavors could be hastened.

At the present time, in addition to the Federal agencies, there are a number of universities involved—and I might also say that private industry, through the Electric Power Research Institute, is a major performer in the overall national research program.

We are also working very closely with our European colleagues in the Federal Republic of Germany and elsewhere, in exchange of scientists and exchange of data and information.

Mr. Olin. Thank you very much. I would like to not take any more time. Thank you, Mr. Chairman.

Mr. Brown. Mr. Gunderson.

Mr. Gunderson. Thank you, Mr. Chairman.

Panel members, as I sit here and listen to everything that has been said, there is no question, I have to agree with my colleague, there is a lot of information.

My one concern would be that as I look at all of the hearings that we have had in this issue and as I listened to everybody in this room, I sort of get the feeling that it is, should we say, paper shuffling between researcher talking to researcher, scientist talking to scientist, each telling each other how important they both are.

I look at Dr. Bentley's statement and he quotes Ralph Hardy in his statement before this committee where he said, U.S. agriculture production and input industries will need to compete in a more rapidly changing world environment several factors: people, training, funding, facilities, programs, technology, transfer and accountability, are identified as key to providing a strong base of science and technology, and he goes on.

I think there is something glaringly missing—that is public support. It just seems to me that while many of you have referenced this idea of education and letting the public know what is going on out there, I am not sure I could speak as affirmatively for my constituents as Mr. Roberts does for his.

If I were to go back today and show them the USDA budget in total and say, if you were going to make cuts, where would you make cuts? I must honestly tell you, one of the big areas that they would cut is research. That may be shortsighted on their part. I am not necessarily defending their position but I am saying that that is, I am quite confident, where they would come from. Because they do not understand the need for research or that they have necessarily received all that many benefits.

Frankly, we wouldn't be all that disappointed in Wisconsin if some of Pat Roberts' wheat crop had not turned out. Because if we had a little less wheat and a little less corn, and a few more insects had eaten a little bit of that, and it wasn't so bountiful and productive, probably we would have better prices in Wisconsin.

So I think that if I were to get my farmers together and they were to get a little bit cynical but a little bit honest at the same time, they would say probably research and productivity that is about fourth has caused some of the problem that we face today.

I guess I think we are on a dangerous course unless we get that public support because, otherwise, nothing else matters. And all of a sudden, the worse thing that you want to do is be halfway through in the breakthrough and development of some particular scientific thought and have it cut off at the knees. And I think you run that risk.

I don't say that to be nasty or to be antagonistic, I say that more to be honest and helpful.

Does anybody have any response to that?

Mr. BENTLEY. Being an academic, I can respond perhaps in length so I have to be careful so that I don't respond too long, I am glad to.

Let me start out by saying that it doesn't matter whether USDA or the land-grant university has trouble, whether it is society that has trouble, and whether American agricultural industry has trouble.

This is not an unusual kind of a dilemma we face. Most countries of the world, including this one, believes that education of the electorate, and education in general is good for a society if it is going to succeed, and it is going to have equity, and do all of the things that a society should do. Yet, it is not uncommon to have a difficulty to get school money, money passed for taxes for schools and education. That has been the history of society.

I happen to be a University of Wisconsin graduate, and the State of Wisconsin probably has more direct relationship to its industry and research it has done at the University of Wisconsin and other universities that they benefit, and the USDA, as any State.

I would agree with your question, you can still get to the same thing. So that, then, says we have, I think, a broad issue.

Now, when you say, is there public support? It depends upon where you go. For example, the commodity groups that we talk to, the representatives that farmers and ranchers and agribusiness organizations have here in Washington or around in our States, are talking to us about the need for more research all the time.

Our pressure is now to get enough funds to meet the needs that people raise. So, that is one indication of it.

There is another indication in terms of the opportunities in science and when one knows that it would be possible, for example, to modify a plant so that you might take less cost, a lower cost way of getting nitrogen to a plant, you know the benefits to the economy of that and to the future.

So one has to talk about these in long-term and realizing it is very difficult sometimes to sell long-term ideas.

I have been around long enough, and gone through enough cycles, to hear farmers object, for example, to hybridization in hogs, as cross-breeding in hogs. I remember very well the argument in the State of Minnesota where the man who introduced that from the Minnesota—they announced his premature death and put a black frame around it in front of one of the breed association newspapers. It hurt that man so badly, he eventually died through depression.

Today, 90 percent, or more, of all commercial hogs are produced through hybridization because they increased the rate of grain and peat efficiency. The same thing has happened in poultry, the same thing has happened in milk production, in forage, and crop production.

So, if those values have something to do with the competitiveness of agriculture in the future, and I think absolutely they will, then that is important.

So, we have the job, but I think the job is everyone's. I think the agricultural itself has to do this; I think the Government, the Congress, and certainly universities have the responsibility to talk about that, because that is, as I see it, a concern for society as a whole.

We know we have to work hard at this and talk to people. On the other hand, I guess that is partly why we are here today, to tell about this opportunity and hope that we can bring it to the attention of leadership.

Mr. **Gunderson**. I think it is more of a statement and a challenge than a question, really, so it is difficult to answer that.

A followup to that would be something that I have said back home as we look to the 1985 farm bill, we ought to fund research but not research to promote more productivity, but more cost-efficient production. The last thing we need is more production in this country.

Now, you kind of touched on this, and certainly the chairman, of this biotechnology research emphasis, as you say, biotechnology research offers the potential to increase plant and animal productivity without increasing input cost.

As the chairman of the Research Council or Committee in Department of th farm bill within the USDA, can you give us some insight as to exactly where you would see the research emphasis in terms of new directions coming next year in your proposal?

Mr. **Bentley**. Yes. I am not sure I know exactly the question. But if we were talking about where we would put emphasis, I think we would go along with the priorities and emphasis that are placed right here in this publication of priorities, that is the areas we would look at would be the need for basic research and certain areas, that includes biotechnology, development of computer base technology for information dissemination, the scientific expertise, the training of people. We are talking about price income analysis as it relates to world trade, world productivity; human nutrition, we think that this is an area that needs attention; and water resource management, are the broader areas that we think of as high priority.

But right along with that, we realize that there needs to be a continuing research, say, in germ plasm, that looks at evaluating the germ plasm pool we have for plant and animal materials; insects, et cetera, in the U.S.; and keeping our technology constant, whether that be in production technology, processing, post-harvest technology, and so forth. There is a body of information that needs to be kept growing. There would be the specific kinds of research areas.

The thing that I would hope that we can do in the process that I referred to in discussion of the farm bill, is to try to do this communication and cross-linking job that I think is so difficult and important to do. That is, when we begin talking about commodity farm prices or trade policies, or natural resource policies, or the feeding, the nutrition programs that we have in the Department, there ought to be some linkage to the developments that are either here now or on the horizon as it relates to science and technology that should be recognized. Because if that isn't done, we have run the risk of making plans based on current information that when they really come to fruition and develop, there has been a change in the production system, or marketing system, or trade policies, that will alter the effectiveness of a given policy recommendation. I hope that we can get this cross-linking into it.

Mr. GUNDERSON. Thank you. Thank you, Mr. Chairman.

Mr. ROBERTS. Would my colleague yield just for a moment?

Mr. GUNDERSON. Sure, go ahead.

Mr. ROBERTS. I just want my colleague to know that we are working very hard to achieve what he has suggested. Two years ago, we had a freeze where we lost one-third of our crop. I didn't really realize that was to help the Wisconsin farmer. But we have also used our product to keep the Russian troops out of Afghanistan. And we have also now, due to real intense effort and a lot of hard work, we have got a price right at a feed grain level, so wheat is now a feed grain.

So we are doing everything we can for the Wisconsin producer but don't count on us for another crop year because I am not too sure that we can sustain it. [Laughter.]

Mr. GUNDERSON. Thank you.

Mr. PENNY [acting chairman]. Dr. Bentley, I want to ask a couple of questions in one area only, and that is the area of meeting the hunger needs around this globe.

In the morning news, there was discussion of the population growth in the last 10 years, indicated that world population has increased by about 800 million, mostly in underdeveloped and developing nations. Even though the rate of population growth is slowing somewhat, we can expect every year to add about 90 million people to the world population.

The alarming effect that that has on starvation is evidenced by statistics that show that in the last 5 years alone, more people have starved in this world than were killed in all the wars over the last 150 years.

Given that as a preface, what emphasis is currently being placed on research that will benefit foreign production of agricultural products? And what degree of coordination exists between the various USDA programs and other programs to respond to the need to produce more food around the globe?

As much as we would like to, our increased productivity here in the United States isn't going to meet the needs of these hungry people in other nations. I think as a moral leader of this world, that we not only have to be concerned about productivity here at home but how we assist productivity abroad.

Mr. Bentley. Again, that is a very broad question, as you know.

Let us take that in parts. As we looked at the direction of the research program and education program under the joint council activities, we did recognize the importance of human nutrition. We didn't speak about this because there is to be a hearing next week, and a joint one involving this committee and the Science and Technology Committee, and that will be discussed.

But it seems to me, that as you think about the food needs in this country, we are thinking trade and possible—one projection is that trade and various kinds of feeding programs on a worldwide basis is probably going to increase the demand something in the order of 40 to 50 percent on cereal grains, and probably more than that on livestock.

I have seen lots of projections like that and they often have problems actually coming true, but there isn't any doubt about it. The trend and the pressure for world food needs is going to increase each year. The United States is going to be part of that through trade but it is also going to be a part of it through concessional grants of food. That is one dimension of it.

The next dimension is that we need to realize that many countries in the world are really improving their capacity to produce, some of them are the less developed countries. For example, India has increased their wheat production substantially, so that they can meet many of their needs, and that is a good development now.

When it comes to the other question, what are we doing here? It seems to me that one thing that the United States has a leadership role, and that happens to fit with a bias of mine, I served on the Board for International Food and Agricultural Development of U.S. AID during the Ford administration. Therefore, I think that the sharing of science and information technology about food production is one of the commitments of this country, and that has been enunciated by President after President and Secretary of State after Secretary of State, indicating that we would share technology. I would hope that we would continue that policy to help others to help themselves, so to speak, to meet their own food needs.

Now, that always runs into problems that could interfere with trade and other questions but that is something that we will have to cope with, I think, and we are coping with right now.

But the sharing of information of science about agricultural is something that I believe is important and we should continue. The exchange of information is done in many ways. For example, through the Agricultural Research Service there are studies conducted at the request of various governmental agencies as USAID of the State Department.

But there is another way that we can share information and that is that there is a scientific community and a community that looks at technology in the food and fiber industry on a global basis. And that comes about through at least three different ways.

One way is through science itself. That is, our scientists and scientists in many developing countries know what is going on here. We have invited—lots of people come here. I think we ought to continue the practice of inviting people from less developed countries to come and just to visit universities. I was with a group from Tanzania just day before yesterday that wanted to talk about our system here. In fact, I am so biased toward that, that I think that is one of the ways to establish to encourage world peace and world understanding, not in a do-gooder sense that you might say, if I can use that word, but in a true sense of self-interest that we would share information and be concerned about it.

The second thing is that our governments—we have various ways through provided funds for developing educational systems, technology capacity to produce technology. And, in fact, it is having an impact on many countries. Unfortunately, some of the countries that are having the most trouble—in Africa, it is slower to get started for a number of reasons, of which I am sure you are familiar with.

The other area that has helped share technology is through some of our industries, multinational groups, if you will, that are trying to encourage and participate with industry in some countries to develop particularly food processing and storage to reduce food losses. If they can just find ways to reduce losses, they could meet a lot of their food needs and stabilize their food supply. That is one area that I believe should continue.

But all of it, from the standpoint of our country, we think as we develop the information that we have that it should be made available to those that need it, and that we should participate with the various agencies, whether it is through multilaterally programs, or what it is, to share information.

It then comes to down saying that it adds to the importance of the matter of competitiveness of our industry, that is, if we have knowledge and we don't use that knowledge, then I think it is something about our own way of approaching life. A good example is to go back on the microcomputers and the semiconductors.

It is rather ironic to know that the development of some of them took place in American laboratories in the late 1940's and early 1950's and we were slow to utilize them, I think—seemingly, we must have, because other countries have been more successful in developing new products than perhaps we have in these areas.

I believe this is the same thing in agriculture, that we have to be applying this knowledge.

That is a long answer but it is a complicated question, but I guess you wanted to know what my philosophy was and I tried to say in words that I have used.

Mr. **Penny**. I appreciate that answer and I also appreciate the personal emphasis that you provide to developing relationships that allow us to share what information we have.

There are, though, differences in soil type, differences based on climate, pests, other threats to food production, and different crops in many of these developing nations.

Are we investing enough here in research in the areas that will be transferable to another setting? And if not, what could you recommend that would allow our Nation to be more specifically helpful to these developing nations in meeting their unique production problems?

Mr. **Bentley**. Perhaps Dr. Kinney would want to comment on this. But let me point out some things. One is, that since World War II, but particularly in the last 20 years, I think we have gotten a broader sense in this country of the importance of understanding soils and climatic problems, special production problems. The elevation, for example, is one thing that 20 years, or 30 years ago, we didn't hear people talking about crops production—well, it depends on what elevation you are talking about, because much of the countries of the world have higher elevations for their growing crops.

There are a couple of things we can think of. One is, that the basic sciences—if we understand some of the basic processes, that is more transferable sometime than specific technologies that is aimed at doing a certain kind of a job, that is one thing; so we can get basic information.

The second thing is that—and, again, perhaps reflects my academic background bias—but training of students, and graduate students. I suppose I can illustrate it by a short antecdote about being in India, leading a group in India for the Department of Agriculture on the Joint Indo-American Commission in January. When we met with the administrative leadership of the research teaching extension programs in India—that is called the Indian Council for Agricultural Research—it has a director general and six deputy director generals. And of the major ones in that group, five of them had all had studies in the United States, and they were leadership. They were scientists, they were already established world class scientists, and they are, in addition, administrators leading the programs in research and extension and teaching programs. It so happened that of those, I knew personally four of them, because of remembering them when they were at the assistant professor level years ago.

Mr. **Penny**. Thank you for your responses.

Congressman Volkmer, do you have any questions?

Mr. **Volkmer**. Yes, I would like to address one issue about some of the recommendations. At least I understand there is a proposal made in regard to funding for the land-grant colleges to change the formula, to change the emphasis on the population as to rural population and total population.

I was wondering if you all had reviewed that, if you all have any position on it?

Ms. **Greenwood**. Perhaps you are talking about the formula relating to the distribution of funds for the Cooperative Extension Service.

As a result of discussion by this committee as well as a group that looked at the future of Cooperative Extension, the Extension Committee on Organization and Policy did put together a task force, with my concurrence, to look at that issue. I believe Dr. Wadsworth, in his testimony yesterday gave the findings of the task force. As far as a departmental position on that particular concern I did keep departmental officials apprised of the deliberations as they were ongoing. The Department has not taken a position at this point in time relative to any modifications in the formula.

It would be my personal judgment that the distribution of current funding be in accord with existing priorities in line with the future of Cooperative Extension.

Mr. BROWN. Would the gentleman allow me to interrupt at that point?

Mr. VOLKMER. Yes.

Mr. BROWN. The presentation yesterday did set forth alternatives but left the final decision dependent upon the policy direction that the Congress might choose to take on Extension.

The question that I would have is this: Has any similar study been made of the distribution of formula grant funds in any of the other programs besides Extension? I haven't seen any such studies and I am interested in knowing if there has been.

Mr. JORDAN. Mr. Brown, you probably are aware that the Experiment Station Committee on Organization and Policy of the National Association of State Universities Land-Grant Colleges has examined this periodically through the years. And there are for the research community seven components in that calculation, some of which may sound like the double counting. For example, the number of people in world population and the number of rural farm units you might think as a sense of double counting. So there has been some of those questions brought up. But when the bottom line turns out, I think you said it extremely well a year ago when you indicated that it probably is a small adjustment one way or the other in the system and the major spikes are probably in programmatic areas. And that is why the system has come forth with issues of animal science competitive grants and biotechnology competitive grants is a major way to make headway.

Mr. BROWN. Thank you. Excuse me for interrupting.

Mr. VOLKMER. I would like to ask Dr. Greenwood if there has been any evaluation made as to if the formula was changed that any of the proposed on Extension, what effect will it have on the various universities and colleges?

Ms. GREENWOOD. Part of the work of the task force was to look at, based upon the various options they studied and what impact that would have on——

Mr. VOLKMER. Specific?

Ms. GREENWOOD. Institutions and States, yes, that information is available. I do not have it at hand.

Mr. VOLKMER. I would like to have a copy of that if it is possible.

Ms. GREENWOOD. All right.

Practically any option they had looked at would increase funds for some States with others getting less. But it has been analyzed, yes.

Mr. Volkmer. You will furnish my office a copy of that?

Ms. Greenwood. Yes, I will.

Mr. Volkmer. I would like to also have a copy of that for the record, Mr. Chairman.

Mr. Brown. Yes, without objection.

[The information appears on pages 652–656.]

Mr. Volkmer. I have no further questions. Thank you.

Mr. Brown. Thank you very much.

Dr. Greenwood, I would ask you to comment on what would happen if the 3(d) programs in Extension were folded in with the General Extension Program? I am not so much interested in financial impact—well, to some degree—but would this result in the termination of these programs, the continuation at reduced levels, or what?

These programs essentially were a way for the Congress to express its views on priorities and they may or may not have been well chosen. There is, of course, some effort now to eliminate the 3(d) funding which is resisted in some parts—I think the Appropriations Committee wasn't too happy about it. But I continue to have questions about whether this is necessary or not, much as I am enamoured of some of the programs. For example, the Urban Gardening Program or the Expanded Food and Nutrition Education Program, which I am very high on.

What would be the impact on these programs if we reverted to the prior status when we did not have these earmarked funds in your operation?

Ms. Greenwood. Mr. Brown, in terms of the 3(d) or earmarked programs within the extension system, each of those has its own formula for distribution to the States. The Expanded Food Nutrition is under one; IPM or our Integrated Pest Management Program on another. Our assessments of folding them into the Smith-Lever 3(c) formula would drastically alter the distribution of fund to any particular State which would have impact on its current programs.

My colleagues and I have discussed another possible option. We have not totally analyzed it at this point, but another option might be to take those 3(d) items and with some modifications in legislation, fold them into section 3(b) which would permit them to be allocated, as they are currently, to the States. Under this option, current emphasis for these programs can be retained; 3(d) programs are a way of addressing particular issues, whether it is on the part of the executive branch or on the Congress, and to influence other resources that a State may have.

I share the belief that after 10 or 15 years, certain 3(d) funded programs may have served that purpose. We need to find a way to deal with that category of programs.

Mr. Brown. All right. Now, I would like to get a few more details with regard to the Competitive Grant Program, if I might. Dr. Kinney, or Dr. Jordan, perhaps you are the best ones to answer this. The uncertainty with regard to the future course of the program and its level of funding, of course, made it difficult for you to perhaps plan as well as you might, but can you give us some understanding of where you stand now? How far along are you in the processes of organizing peer panels? Are you facing any obstacles in the way of financing for the mechanics of the program? Just try and give me a little feel for what the situation is and is likely to be over the next year.

Mr. Kendrick. Yes, Mr. Brown, I will attempt to respond to that.

We are planning ahead based on the President's budget request for the $33 million increase in the Competitive Research Grants Program, $28.5 million for a biotechnology initiative, and $4.5 million on the Animal Science Program.

We know how many additional panels we would need to handle this workload. We have already worked out a schedule of when the panels would meet. We recently met with our Policy Advisory Committee to discuss more specifically how we might allocate those funds, and reviewed with them the areas that we would fund in.

Mr. Brown. Can you provide some of that detail for the record, or is that going further than you would like to go?

Mr. Volkmer. Mr. Chairman?

Mr. Brown. Yes.

Mr. Volkmer. Would you yield on that?

Mr. Brown. Yes, certainly.

Mr. Volkmer. Are you issuing to the various institutions notices of opportunity, or are they unsolicited, or how are you doing that?

Mr. Kendrick. We have not put out a notice, and we will not put out a notice until we know the——

Mr. Volkmer. Do you plan to?

Mr. Kendrick. Yes. We have already started the process for soliciting for grants in existing programs for the $17 million that we have—the $15 million in the plant sciences, and the $2 million in human nutrition. That is in the process of going through the clearance procedures now and will be announced shortly.

We have moved the schedule up for solicitation of those proposals in fiscal year 1985 in anticipation that we might have to start up the biotechnology in the animal areas.

Mr. Volkmer. Do you have any maximum—if the gentleman will yield—do you have any maximum that will be put on, or any cap on any one grant?

Mr. Kendrick. No, sir, we do not decide that at the front end. We wait until we get the proposals in and see what the requests for funds are. There are negotiations on the budgets that are submitted. We give each panel some guideline figures to work within.

Mr. Volkmer. What about the period of time on the proposals, whether it would be 1, 2, or 3 years?

Mr. Kendrick. Our announcement, I believe—we would say proposals will be solicited generally for periods of 2 to 3 years. We would like to go 3 years, but we let them know that we may negotiate down to 2 years. But we suggest that a 2- to 3-year period is what they project for with the opportunity to continue.

Mr. Volkmer. Thank you, Mr. Chairman.

Mr. Brown. Since the testimony of the work of the McKnight Foundation, I think it was, is fresh in our mind, are you including both individual and interdisciplinary grants in the program?

Mr. Kendrick. We believe that the record would show that while we have a primary investigator, when the proposal comes, that a great portion, or great majority, of the proposals really are interdisciplinary. If you review it through and you find out what the interactions are, but right now we don't have a specific category—we will only consider it if it is interdisciplinary.

Mr. Brown, I would say that we discussed that and we have noted the questions in the briefing material, the issues paper, and it would be obviously much easier to set up a category like that when we had a more substantial program. It is very difficult at this point, we feel, to set that up as a distinct category.

Mr. BROWN. I understand that the present ambiguity with regard to next year would cause some problems. Basically, what I would like to have in the record, if you can, is sufficient filling out of some of these details to aid us in the process of resolving some of these ambiguities about next year's funding.

Mr. JORDAN. Mr. Brown, you may be interested in the amount of homework that has been done in some of these arenas. For example, Dean Charles Hess has assisted us by surveying every State agricultural experiment station in the country. We know exactly how much research they have had in the fiscal year that just closed last fall. We know the distribution between plant and animal work and that is in the general biotic area, and not distributed between those.

We also know from the study, the number of FTE's, of faculty, students, and staff, that they all plan to gear up in that $28½ million. And if that were allowed to occur, sir, then the size and scope of the programs would be much closer to $250,000 per year, per investigator, for science this year, which would be almost double what we are putting in now. And that probably, Mr. Brown, would be very critical to carrying out the more expensive programs in biotechnology.

Mr. BROWN. Again, I am asking you if you can provide some of that material for the records including Dr. Hess' work?

Mr. JORDAN. Yes, sir, we would be glad to.

Mr. BROWN. Fine.

[The information follows:]

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

July 11, 1984

Honorable George E. Brown, Jr.
House of Representatives
Washington, D.C. 20515

Dear Congressman Brown:

At the hearings before your subcommittee on Department Operations, Research, and Foreign Agriculture, on June 13, 1984, you requested that we send you (a) information on our plans for administering the proposed $33 million increase in the Competitive Research Grants (CRG) Program for FY 1985, (b) information on current biotechnology activities, and (c) an explanation of the problems of operating the scientist peer review panels under the provisions of the Federal Advisory Committee Act (FACA) and the funding limitations of both authorizing and appropriations legislation.

Plans for administering an increase of $33 million in Competitive Research Grants ($28.5 million for biotechnology and $4.5 million for Animal Science): The attached charts (Exhibits 1 and 2) provide a schematic of our plans for administering a $50 million CRG program. Exhibit 3 is a narrative summary of how we would handle the increased workload.

The ongoing Competitive Grants Program of $17 million in 5 categories is administered with a budget of $510,000 (3% of $17 million), a staff of 13 permanent full-time employees and 8 temporary part-time experts. These experts working up to one-quarter time serve as managers in the 5 program categories, and 1 serves as the Chief Scientist, working up to one-third time. Six peer panels involving about 65 scientists are used to review and evaluate proposals. With the proposed increase of $33 million, the administrative budget would be authorized at $1.5 million. The permanent staff would be increased from 13 to 19, the expert staff from 8 to 13, and the peer panels from 6 to 12 to handle the 12 program categories (Exhibit 2). The increased grants activity would also necessitate adding 3 clerical staff to the Grants Administrative Management Office (increase from 15 to 18) which processes and administers nearly all the USDA Science and Education grants (including special grants) once they are approved.

We have already contacted and gotten commitments of potential program managers (experts) for most of the 6 new panels. Regarding permanent staff, we would hire two additional associate program managers in the animal science area—one a molecular biology-oriented scientist and the other with a reproductive physiology background. All new plant science areas will be taken care of by existing associate program managers as shown below:

Nitrogen Fixation and Photosynthesis—Ms. Iris F. Martin

Environmental Stress—Dr. Olga v.H. Owens

Genetic Mechanisms and Plant Science Component of Growth and Development—Dr. Machi F. Dilworth

Biological Stress—Ms. Anne Holiday Schauer

Human Nutrition and Animal Science—Associate Program Manager being recruited

Animal Science, Biotechnology—Associate Program Manager being recruited

The amounts added for numerous relatively small specified programs in the House version of an FY 1985 CRG program are undesirable from both the scientific and management viewpoints. It would be most inefficient to hire 7-9 additional associate program managers, a like number of part-time experts, solicit competitive applications, set up panels, and make awards when the amounts (except for Animal Health) are so small.

Current Biotechnology Activity: Dean C. E. Hess of the University of California at Davis recently surveyed all the State Agricultural Experiment Stations to ascertain (a) their current involvement in biotechnology and (b) their plans to "gear up" for an expanded biotechnology program as recommended by the NASULGC. The results of the latter are seen in Exhibit 4. This evidence suggests that the SAES's will have the capacity to effectively compete for and utilize a significant share of the proposed increase. With regard to current involvement, the following data were obtained:

- Currently, there are 579 active projects funded in the amount of $41.5 million broken down as follows:

Federal funds	$19.8 million
State funds	$16.2 million
Private funds	$5.5 million

- Funds for the 579 active projects are distributed as follows:

Plant cell research	43%
Animal cell research	28%
Biotic systems research (not specific for plant or animal)	29%

- Of the 608 breeders working on biotechnology research, 451 (74%) were plant breeders, and 157 (26%) were animal breeders.

- The Multidisciplinary projects in the Regional Research program average $140,000 per year of USDA funding, but have other funding (state, grants, etc.) that bring them to about $570,000 per year total funding.

Funding Limits—Federal Administration: By legislation (the current Farm Bill), we are permitted to use only 3% of the appropriated funds to administer the CRG program. The National Science Foundation figures about 5% for administration of their CRG programs which is closer to our "real" administrative costs of 5-6%. Appropriation language for FY 1984 and the Department's FY 1985 asking limits the Department of Agriculture to $1,398,000 for all Advisory Committees (committees under FACA), and our peer panels have been determined to fall under FACA. Science and Education is allotted $533,000 of this total and is seeking an increase to $630,000 for FY 1985. For FY 1984, we budgeted $164,000 for scientist peer panels in our CRG program and estimate a budget of $268,000 for FY 1985.

We, in fact, had to ask panel members who will conduct the congressionally mandated peer reviews of proposals for the FY 1984 $5 million Higher Education fellowship program to pay their own travel and per diem so as not to exceed the $533,000 limit for S&E Advisory Committee activity. In order to carry out peer panel reviews for a $50 million CRG program in FY 1985, the Department will need to seek an increase on the dollar ceiling for Advisory Committee activities or seek exemption from the CRG panels falling under FACA. As with the CRG programs of the NIH, NSF, and other federal agencies, the use of scientist peer panels to review and recommend funding of grant proposals is essential to the success and quality of these programs.

We recommend these scientist peer review panels be exempt from the FACA in the same way NIH Study Sections are exempt, or at least they should be exempt from the expenditure limitation on Advisory Committees for the Department.

Thank you for your consideration of this request.

Sincerely,

Orville G. Bentley
ORVILLE G. BENTLEY
Assistant Secretary
Science and Education

(Exhibits follow:)

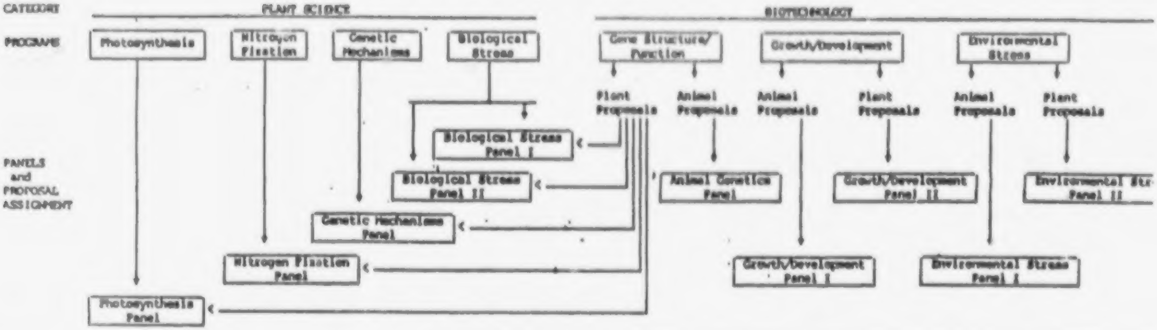
Exhibit 1

FY 85 - Program Plans

Programs/ Panels	Proposal Due Dates '84-'85					Panel Meetings		
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Biological Stress I	1					Early	Late	
Biological Stress II						Late		
Genetic Mechanisms	1					Late		Early
Nitrogen Fixation			17				Early	
Photosynthesis	15					Late		
* Gene Structure				14			Mid	
* Growth/Development I					4			Mid
* Growth/Development II					4			Mid
* Environmental Stress I				14			Mid	
* Environmental Stress II				4			Late	
Human Nutrition			17			Mid		
* Animal Science				28				Early

* New programs and panels

PANEL ASSIGNMENT PLAN FY-85


CATEGORY
PLANT SCIENCE
BIOTECHNOLOGY
PROGRAMS
Photosynthesis
Nitrogen Fixation
Genetic Mechanisms
Biological Stress
Gene Structure/Function
Growth/Development
Environmental Stress
Plant Proposals
Animal Proposals
Animal Proposals
Plant Proposals
Animal Proposals
Plant Proposals
PANELS and PROPOSAL ASSIGNMENT
Biological Stress Panel I
Biological Stress Panel II
Genetic Mechanisms Panel
Nitrogen Fixation Panel
Photosynthesis Panel
Animal Genetics Panel
Growth/Development Panel II
Environmental Str Panel II
Growth/Development Panel I
Environmental Stress Panel I

Biological Stress Panel I — Plant Pathology/Weed Science
Panel II— Entomology/Nematology

TOTAL = 12 Panels needed

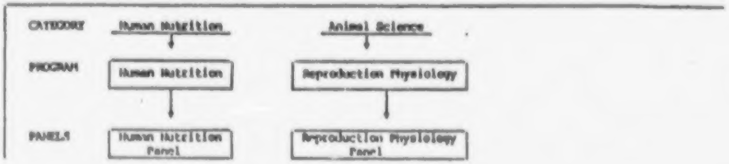

CATEGORY
Human Nutrition
Animal Science
PROGRAM
Human Nutrition
Reproduction Physiology
PANELS
Human Nutrition Panel
Reproduction Physiology Panel

Exhibit 2

SUMMARY

I. Panels/Program Managers needed

- a. 12 panels and 12 program managers needed
  (Biological Stress split into 2 subprograms)
- b. Commitments from scientists for the 6 new program manager positions will be completed by July 1, 1984.
- c. Certain panels might need to meet twice.
  For example: Plant Science - Genetic Mechanisms
  Biological Stress I

II. Proposal Assignments

- a. Proposal assignment and distribution of funds to the different panels will be the responsibility of the Chief Scientist. Distribution of funds will be based upon the numbers of high priority proposal designated by each panel.
- b. Proposals in the programs under Biotechnology will be assigned to the panels indicated based upon research area designated and animal or plant orientation.
- c. Plant oriented proposals submitted to the Biotechnology - Gene Structure/Function Program will be assigned to one of the plant science panels depending upon subject addressed. For example, proposals on structure and function of chloroplast genome would be assigned to the Photosynthesis Panel. It is anticipated that most of the proposal on plant gene structure-function would be assigned to the Genetic Mechanisms Program, however.

Exhibit 4

Table 5. Projection of additional personnel commitments to biotechnological research within the next two years (prior to July, 1984) by the State Agricultural Experiment Stations.

SAES Reporting Biotechnology Projects	Faculty	Student	Staff
		FTE's*	
Arizona	3.0	2.00	0.0
Arkansas	0.0	0.00	0.0
California			
Berkeley	5.0	5.00	2.0
Riverside	4.0	9.00	4.0
Davis	2.0	7.00	1.0
California Total	11.0	21.00	7.0
Colorado	2.0	4.00	2.0
Florida	15.0	15.00	10.0
Georgia	1.0	2.00	2.0
Hawaii	1.0	1.00	0.0
Idaho	0.5	0.00	1.0
Illinois	2.0	5.00	3.0
Indiana	3.0	8.00	4.0
Iowa	3.0	1.00	1.0
Kansas	?	?	?
Kentucky	5.0	8.00	5.0
Louisiana	1.0	2.00	0.0
Maine	2.0	5.00	5.0
Maryland	1.0	2.00	0.5
Massachusetts	0.5	2.00	1.0
Michigan	4.0	8.00	4.0
Minnesota	1.5	1.50	1.5
Mississippi	1.0	4.00	2.0
Missouri	2.0	10.00	4.0
Montana	0.0	0.00	0.0
Nebraska	2.0	2.00	2.0
New Hampshire	0.5	0.25	0.5
New Jersey	?	?	?
New Mexico	1.0	4.00	2.0
New York	15.0	26.00	25.0
North Carolina	3.6	0.50	8.0
Ohio	4.0	6.00	4.0
Oklahoma	7.0	7.00	7.0
Oregon	3.0	1.50	1.5
Pennsylvania	1.6	1.60	3.0
Puerto Rico	?	?	?
Rhode Island	1.0	3.00	2.0
South Carolina	0.0	0.00	0.0
South Dakota	1.0	1.00	--
Tennessee	0.0	0.00	0.0
Texas	4.0		8.0
Utah	3.0	3.00	2.0
Virginia	2.0	4.00	0.0
West Virginia	0.0	0.00	0.0
Wisconsin	0.0	0.00	0.0
TOTAL	106.2	161.35	118.0

*Full-time equivalents

Mr. Brown. I don't want you to go to unnecessary labors or to duplicate anything that is in your presentation this morning, but fill us in a little bit on that.

Mr. Kendrick. Mr. Brown, you asked about any problems that we might be encountering.

Mr. Brown. The problem, for example, of financing your peer panels.

Mr. Kendrick. Currently, in this last fiscal year, to bring our panels in, travel and all the associated costs there—for instance, we have a budget of about $164,000. We have projected that out, what we will need with six additional panels in fiscal year 1985, and we would go up to about $270,000 is what we ought to allot.

Now, we have a limitation by the Congress, the Department is allowed to spend only $1.4 million for advisory committee activity, period. By law, we can spend up to 3 percent of the competitive research grants funds for administration.

But this other limitation on advisory committee activity will greatly hamper our ability to conduct adequate peer panel reviews.

Mr. Brown. I presume that language is contained in an appropriation bill rather than an authorization bill?

Mr. Kendrick. Yes.

Mr. Brown. Why don't you provide the committee with some language that would fit into an authorization bill that would meet your needs in that connection, and we will override the appropriation language.

Mr. Kendrick. We will be pleased to do that, sir.

[The Department will include this as part of its comprehensive recommendations for farm bill changes.]

Mr. Brown. Do you have any further questions?

[No response.]

Mr. Brown. If we have other questions, ladies and gentlemen, we would appreciate your willingness to respond to any written questions that we provide.

Mr. Brown. We want to thank you for your patience and for the excellence of your presentations this morning. It has been extremely helpful to us.

With that, the subcommittee will be adjourned.

[Whereupon, at 12:25 p.m., the subcommittee adjourned.]

[Material submitted for inclusion in the record follows:]

STATEMENT OF DR. ORVILLE G. BENTLEY, ASSISTANT SECRETARY, SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE

Mr. Chairman and members of the Subcommittee, I appreciate the opportunity to appear before you to discuss an issue of vital importance to our Nation: agricultural research and education programs and policies.

My remarks today have three purposes: first, to inform you of the status of the newly implemented series of reports prepared under the direction of the Joint Council on the Food and Agricultural Sciences; second, to respond to a number of questions you have raised; and finally, to explain briefly an important new interagency effort we have initiated to help find better answers to some farm policy issues.

In the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended in 1981, the U.S. Congress reaffirmed the need for a publicly supported science and education system in agriculture. To meet future needs and challenges, the legislation required the development of a long-term needs assessment (20 to 30 years), a medium range planning document (5 years), an annual priorities report, and an annual accomplishments report. This Congressional mandate provided a unique opportunity for the performers of agricultural science and education programs to examine emerging problems and issues and to communicate--both among themselves and to outsiders--how the scientific community can help find solutions. With such planning, managers are better able to control conditions by anticipating future events and acting accordingly.

It is my pleasure to report that the first round of these reports has been completed and provided to Congress. Their development involved the participation of many federal, state, and private-sector scientists, educators, and administrators. For example, the Needs Assessment Reference Document includes 16 separate papers authored by over 40 nationally prominent scientists and educators. Several organizations and interest groups provided input for these reports and for the priority-setting process. They included the policy committees aligned with the National Association of State Universities and Land-Grant Colleges--ECOP, ESCOP, and RICOP; National Agricultural Research and Extension Users Advisory Board; professional societies; industry representatives; and individual users of science and education programs.

The exciting aspect of this total exercise is the apparent usefulness of these reports. We have received several letters and comments from administrators and scientists within the decentralized system of agricultural research and education. Some states are using the procedures employed by the Joint Council as a basis for formulating new directions within their colleges of agriculture. The national priorities have to be reformulated to satisfy state and local needs, but they provide a general guideline for meaningful discussions and hard decisions that need to be made, especially when resources are limited. Others are using the documents for communication purposes--to administrators and scientists in other colleges and agencies, legislators, and leaders of agricultural groups. Dr. John Dunbar, Dean of Agriculture at Kansas State University, called the Needs Assessment Summary "A document which reflects a blueprint for our research and extension programs for the next 20 years".

The need for the reevaluation of science and education programs was well stated by Ralph W. F. Hardy in testimony before this committee on June 6, 1984. He said:

> U.S. agricultural production and input industries will need to compete in a more rapidly changing world environment. Several factors--people, training,

> funding, facilities, programs, technology transfer, and accountability--are identified as key to providing a strong base of science and technology to maintain or hopefully increase the competitive position of U.S. agricultural industries.

Mr. Chairman, in your letter of April 9, 1984, you indicated a desire to address issues raised in recently completed planning reports. Some of these issues concern specific Science and Education (S&E) agencies in USDA. The agency administrators will address those issues later in this hearing. However, other issues concern all or most S&E agencies in the department, and I will comment on those now.

In regard to the biotechnology initiative, the charter for this hearing raises questions about allocations of resources, linkage among federal performers, regulatory concerns, and secondary impacts on the agricultural economy. These are questions that need answers, and they will be addressed by other witnesses. I would simply like to emphasize to you the significant opportunities that would be foregone if this program is not implemented as proposed in our 1985 budget proposal.

Biotechnology research offers the potential to increase plant and animal productivity without increasing input costs. The possibility of reducing loss from disease and insects, improving nitrogen fixation, and creating new microorganisms that are more efficient in converting waste lignin and cellulose to simple carbohydrates and sugars appears to be within reach. The promising new processes just beginning to find commercial applications are themselves the result of decades of fundamental research. In the years ahead there is every reason to believe that biotechnology and related research in agriculture and forestry will produce payoffs as great as any in the past--payoffs that will increase the efficiency with which we produce our food, fiber, and forest products; that will reduce the adverse impact of our modern production systems on the environment and on our non-renewable resources; that will increase the quality and assure the safety of our agricultural products for markets at home and abroad; and that will increase our storehouse of fundamental knowledge on which the new major advances in agriculture will be built.

The charter for the hearing recognized the major step forward taken by the Joint Council on Food and Agricultural Sciences when it ranked eight national priorities for FY 1985. The top one--biotechnology research--did receive major emphasis in the proposed 1985 budget. Because of severe budget constraints, only a few of the remaining seven priorities were proposed for increased federal funds at this time. This does not mean, however, that the other priorities will be ignored. Both federal and state performers are evaluating their current program mix and looking for opportunities to redirect resources into high priority areas.

During the last six months the Joint Council has discussed in some detail two of the top priority areas--forestry and conservation. Scientists and administrators from the federal, state, and private sectors met with the Joint Council to discuss the significance of the forestry industry in the United States. They mentioned six agenda items needing action:

- basic research/biotechnology,

- new program directions,
- education needs,
- international programs,
- vitality of the system, and
- funding trends.

The needs of the forest research and education community could well be the basis for a review next year by this committee or the science and education committee. Later in this hearing another witness will address this subject in more detail.

The Soil Conservation Service (SCS) presented information to the Joint Council on major conservation issues needing attention by the research and education community. These include:

- erosion/productivity relationships,
- offsite effects of erosion,
- water management issues and rangeland conservation, and
- conservation incentives.

Natural resource programs have received additional support in recent years, and the Agricultural Research Service and others are responding to the needs expressed by SCS.

Mr. Chairman, in the charter for this hearing, there is a suggestion that the accomplishments report should be used to show progress in priorities ranked in the priorities report. We feel that is a good suggestion, and it will be discussed in an upcoming Joint Council meeting.

The suggestion that high priority areas should receive more analysis in future priorities reports can also be examined by the Joint Council. This analysis could include the economic significance of improved or new technologies and potential spinoffs--social, environmental, and scientific. We do not think that a critical path analysis is necessary for high priority areas identified in the priorities report. If a major thrust is envisioned, a critical path analysis would be the responsibility of the agency and/or university performing the work.

The suggestion that supply-demand projections should be more closely connected to research needs is valid. Gary Taylor of the Economic Research Service is now helping with the Joint Council reports, and should bring some expertise and knowledge to this issue. The Agricultural Research Service considers economic information in determining program direction and currently has Ira Branson on detail to the Economic Research Service to improve the linkage between the two agencies. Obviously, economic information is an important ingredient in planning biological and physical science research and should be a more integral part of research planning.

During the coming year the Joint Council on Food and Agricultural Sciences intends to examine one facet of this supply-demand issue: How can agricultural production be more closely connected to changing human nutrition requirements? Human nutrition scientists and plant and animal production scientists need to communicate their findings to each other. Producers need help in adjusting to changing markets. New biological research techniques have made it more feasible to reduce or eliminate undesirable nutrient characteristics in plants and animals. These new techniques can make an important contribution to adjustments that farmers and the food industry will have to make. Both social and biological scientists should be involved in addressing this issue.

All the discussion about new opportunities and emerging issues should not be taken as an abandonment of traditional research and education programs. One major area of responsibility of the food and agricultural sciences is maintenance research, which is the research needed to offset the forces that would otherwise result in productivity losses. As agriculture becomes more dependent on sophisticated technologies to produce and process food, fiber, and forest products, it takes more effort to maintain the effectiveness of these technologies.

A broad range of activities is covered under the umbrella of maintenance research. Upgrading the disease and insect resistance of plants and livestock is central to maintenance research efforts and involves a diverse group of scientists, ranging from plant and animal physiologists, to pathologists, entomologists, silviculturists, and agronomists. Management practices continually change, requiring new information and skills. Just like buildings and equipment, technology depreciates in usefulness and must be updated.

A unique aspect of the agricultural industry is that the product is biological, subject to the vagaries of weather and the threat of weeds, insects, and diseases. The results range from local misfortunes to national emergencies. The best way to prevent a crisis is to identify and treat the problem early. Two examples of unexpected occurrences were the tussock moth outbreak and the corn leaf blight. Because scientists were studying these organisms, biological processes were understood. Remedial action was taken in time to avert disasters of national and international dimensions. In an unfinished manuscript, Donald L. Plucknett, currently with the World Bank, estimates that about 40 percent of the research in the agricultural sciences is devoted to maintenance research.

In addition to maintaining the productivity levels of scientific agriculture, the system must also train scientists for the future. State Agricultural Experiment Stations and the Cooperative Extension Service are integrated into the Colleges of Agriculture at the land grant universitites. These are educational and research institutions that are staffed by professionals who not only conduct research but teach students and extend information to producers and consumers. A broad base of professional competence is essential in each subject-matter area and discipline to cover these multiple areas of responsibility.

Finally, Mr. Chairman, I would like to make you aware of an effort the administration has underway to prepare for next year's hearing on the 1985 Farm Bill. Six subcommittees have been established, under Deputy Secretary Lyng's leadership, to examine alternatives to current programs. The six subcommittees are: Farm Commodity Programs, International Trade and Food Assistance, Resource Conservation, Farm Credit and Rural Development, Feeding and Nutrition Programs, and Research. I chair the Research subcommittee, which includes representatives from Health and Human Services, National Science Foundation, Office of Management and Budget, Office of Science and Technology Policy, and the Interior, Commerce, and Energy Departments. The basic responsibility of the subcommittee will be to develop a factual background paper to help us focus on future Science and Education policies. The first draft of the background paper is scheduled for completion by the end of this month.

We feel that this exercise provides us with a tremendous opportunity to show how new knowledge from the food and agriculture sciences can help provide solutions to significant agricultural problems. If farmers can't sell their products at a profitable price, there is either a marketing problem, a cost problem, or a quality problem. As in the past, research and education can help the producer and processor do a better job in all three areas. The solution cannot be found over night because the issues are very complex. Exchange rates, interest rates, and other economic and political factors are very important aspects of this overall problem, but in general are not subject to easy control by any one sector of the national or international community. Nevertheless, by bringing together the expertise of knowledgeable people who can examine the problems from many viewpoints, we believe that we can bring about significant improvements for both producers and consumers.

Mr. Chairman, I am grateful for the opportunity to appear here today to engage in a meaningful discussion of agricultural research and education programs. I will be pleased to answer any questions you or other members of the committee may have.

STATEMENT OF DR. TERRY B. KINNEY, JR., ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to be here today. Dr. Bentley has given you an overview of the agricultural research system, and I would like to more fully discuss the activities and concerns of the Agricultural Research Service (ARS) which you requested we address.

The ARS is the principal intramural research agency of the USDA. The mission of the ARS is to plan, develop, and implement research that is designed to produce the new knowledge and technologies required to assure the continuing vitality of the Nation's food and agricultural enterprise. As a Federal research agency, ARS (1) solves problems that are of legitimate national concern, (2) conducts research that is appropriate for the Federal government, and (3) exploits the unique capabilities of ARS scientists and the facilities they operate to conduct mission oriented, fundamental, and applied research to solve problems. This is a combination that forms an integrated and coordinated national resource that is not duplicated by others in the full U. S. agricultural research and development system.

As a centrally managed Federal research agency, ARS is uniquely qualified to implement a national level mission for the benefit of producers and consumers of the Nation's agricultural products. In order to achieve its mission, ARS has developed a long-term ARS Strategic Program Plan and a 6-Year Implementation Plan which establish research priorities. This Committee is well aware of the goals and objectives of those plans, Mr. Chairman, such as addressing the current and future needs of agriculture for managing its natural resources, producing and marketing food and other products, and providing nutritious and wholesome foods at reasonable costs. The Plan describes the kinds of research that scientists of ARS think will be needed to achieve the objectives.

The intent is to communicate, in an understandable way, the relevance and importance of the agricultural sciences for the future well-being of the United States. The Plan describes the way in which ARS plans to mobilize its scientific resources to help achieve the objectives of mission oriented fundamental and applied research. The Plan also provides for the continuous review, evaluation, and updating of ARS research to insure both scientific excellence and continued relevance.

The 6-Year Implementation Plan is a statement of ARS program priorities and overall research direction for the planning period--1984-1990. This Plan helps guide ARS scientists who develop research projects, along with other agency decisionmakers at all organizational levels. It also provides important information to organizations that cooperate with ARS, use ARS research findings, or provide resources for ARS activities. Plans are never static. The ARS must and will respond to expected and unexpected problems, technological advances, research opportunities, and to changes in public policy. Therefore, the 6-Year Implementation Plan is reviewed and updated as needed. But no major changes have been made to the Plan.

In addition to the development and implementation of the ARS program plan, ARS has undergone organization changes here at headquarters and more recently in regional and area offices. Every change made to date has been to improve the organization, focus on national research priorities, improve overall management responsiveness, improve accountability, and streamline communications. This year, Mr. Chairman, we have reduced the number of areas and centers in ARS from 25 to 11. The Area Directors now report directly to me, thus assuring control of program and funds from headquarters rather than from four regional and 25 area offices. In addition to these significant changes in line research management and administrative management, we have reorganized the National Program Staff to strengthen its national overview, national responsibilities, and national functions. Through these actions, ARS has identified over 350 additional positions that can be reassigned to research.

ARS maintains a continuous program of intensive communication, problem identification, problem prioritization, planning, program review, research priority establishment, coordination, and analysis. This is required in order to assure that the Agency's major program policies and research priorities and their execution are providing optimal means of realizing the ARS national research program strategy. We will respond to new problems and to new scientific opportunities to improve agricultural efficiency without neglecting our historic responsibilities to farmers, the agricultural industry, and consumers.

For example, the problem of maintaining and improving soil fertility is not new, Mr. Chairman, but recent scientific advances have opened up new research opportunities. We have recognized for some time that inadequate attention has been given to basic research on soil fertility and the chemical and biological properties of soils as they relate to optimum crop production and resource conservation. As crop yield potentials are increased, new research is needed on soil-plant-nutrition relationships so that soil fertility and its management are optimized and do not become barriers to continued increases in future U.S. crop yield levels. The FY 1985 ARS budget request includes an increase which will be used to establish a coordinated network of ARS projects across the country to investigate biological, chemical, and physical interrelationships within soils comprising a spectrum or variety of agricultural production systems, including organic farming.

There is correlation between ARS research priorities and the needs assessments and priorities that have been developed by nationally oriented organizations. Mr. Chairman, in furtherance of its continued effort to assure that our research meets the needs of American agriculture, ARS is moving forward in both planning and implementation to strengthen and focus on the biotechnology and bioregulation sciences. ARS and the National Academy of Sciences have initiated a study, "A National Strategy for Biotechnology: Science and Technology in Agriculture." The study is due to be completed this September. It will be of great value to this Agency in planning the research programs in molecular biology and agriculture science and technology.

Another step to enhance our programs in the new biotechnologies is the establishment of the "Plant Gene Expression Center" at our Albany, California, facility. This laboratory will concentrate on the basic studies that will generate fundamental knowledge and technology that will undergird any practical application of plant gene expression. This Center will strengthen cooperative programs with Federal, other public, and private research groups.

ARS is currently redirecting resources saved from management realignment into several biotechnology program initiatives at our Northern and Southern Regional Research Centers. Examples of these initiatives are:

o genetic engineering of rumen microorganisms to improve efficiency of feed conversion and animal growth; and

o improved conversion of agriculture products to higher-valued materials through biotechnology.

A number of new scientists will be onboard this fiscal year to initiate these projects. The Agency has already financed the renovation and some new equipment for the initiatives.

Research results must be put into the hands of those who need them. ARS has made major progress in developing an ARS technology transfer Plan and has recently appointed a full-time Technology Transfer Coordinator. With the permission of the committee, we would like to include this Plan in the record of these hearings. The Plan attempts to improve the technology transfer capability of ARS scientists. A computer network has been instituted to speed ARS research results to Federal and State Extension specialists. Currently in a pilot-testing stage it will be expanded to all 50 states early next year. This will reduce, by up to a year or more, the time necessary between the completion of research and its use by Extension.

The Pennyslvania State University study on technology transfer is nearing completion and promises to provide policy options for other improvements in the USDA-Land Grant Systems efforts.

Mr. Chairman, while we have our research and technology transfer plans in place, we would be remiss if we did not consider the implications of recent studies regarding the future availability of scientific expertise in the food and agriculture sciences.

The higher education community in colleges of agriculture is currently at a critical juncture in terms of program quality and enrollments. The ability of American agriculture to continue as a leader in world food exports is dependent on the Nation's supply of agricultural scientists and professionals.

The Office of Higher Education Programs (HEP) has been quite actively involved in a variety of projects with cooperating institutions to encourage and assist colleges of agriculture in strengthening their capacity to produce the requisite graduates and professionals in the food and agricultural sciences. Cooperative ventures with various universities and others have been initiated to address some of the critical areas in agricultural higher education. I would like to provide detailed information on these activities for the record.

Additionally, I would like to highlight some of these activities because of their particular importance to the food and agricultural sciences higher education community.

o National Agricultural and Natural Resources College Curriculum Development Project

In September, 1982, the USDA Higher Education Office requested Dr. Richard Merritt of Rutgers University to conduct a National Assessment of Agriculture and Natural Resources Curricula to identify and prioritize needed changes. A $25,000 planning grant was awarded for this purpose. This assessment was concluded in July, 1983 with twelve high priority course areas identified and the recommendation made that courses be developed in these areas in order to strengthen curricula in agriculture and natural resources. Representatives from the two major higher education associations in the U.S. concerned with agriculture and natural resources, a Business Industry Advisory Committee, the USDA Joint Council's National Higher Education Committee, and the director and staff of the USDA Higher Education Programs office participated fully in this study. This project has attracted considerable interest and has garnered a significant commitment of resources from the private sector as well.

o Assessment of Competencies Needed by Future Agricultural Scientists

The Board on Agriculture of the National Research Council of the National Academy of Sciences, at the request of USDA, is presently directing a major study of trends in competencies needed by future agricultural research personnel at the doctoral and post-doctoral level. NAS has established a committee of experts from land-grant private colleges and universities, industry, and government. The committee has met with panels of highly successful research scientists, research administrator, and science educators; has evaluated trends in doctoral degrees conferred; and has reviewed profiles of scientists from undergraduate education, graduate and post-doctoral training to employment. The committee's report on future needs based on observed trends, including recommendations, will be completed by January 1985.

o Food and Agricultural Education Information System (FAEIS)

ARS has been pleased to provide seed money to initiate FAEIS to better meet our needs for statistical data. A cooperative agreement, with Dr. Dwayne Suter as project director, has been in place at Texas A & M University for a couple of years to design and implement FAEIS. However, total funding to date has been less than $150,000.

As you know, the development of an information system involves the assessment of user needs, identification of available data, identification of essential data which are unavailable and need to be collected, acquisition or collection as such data, identification and acquisition of necessary personnel, development of delivery procedures, and development of user information manuals.

Extensive work has been done to identify users' needs, essential available data, and necessary data to be collected. However, these steps are dynamic and ongoing in nature so they are never fully completed. Additionally, much effort has gone into the acquisition of previously unavailable data such as that pertaining to faculty, graduate student support, and academic programs.

The FAEIS project has been largely responsible for stimulating the education community to assume responsibility for acquiring these new data. The project is currently at the state of entering and editing these data along with other data acquired regularly from the Department of Education, the National Academy of Sciences, and the Department of Labor. Identification of suitable computer software and hardware is in process. Hence, we fully anticipate that some elements of FAEIS can be on line in a reasonable time if progress continues.

In FY 1984 the Higher Education Programs (HEP) office is managing the Food and Agricultural Sciences National Needs Graduate Fellowships Program. This program consists of a $5 million appropriation for competitive grants for all colleges and universities offering a master's or doctoral degree in the targeted field for which they are seeking fellowships. Of the amount available for this program, 90% will be for doctoral candidates and 10% for master's candidates in selected fields. We anticipate that this program will support the recruitment and first year of training for some 300 new graduate students in biotechnology, food and agricultural marketing, agricultural engineering (including soil and water conservation and management) and food science/human nutrition. Students supported must be U.S. citizens. Our current schedule shows proposals are due by close of business July 20, 1984; peer review scheduled for August 14-18, 1984; and final decisions by HEP approximately August 20-25, 1984.

Announcements and related application materials have been mailed to almost 2000 addressees. In addition, there have been numerous calls requesting materials. Without exception, feedback received by our HEP staff from the academic community has been very positive.

With regard to the Committee's inquiry relative to amending Title XIV to encourage state or private matching of higher education grants, it is our belief, and one shared by the academic community, that current language contained in Section 1417 of Public Law 95-113, as amended, is unnecessarily restrictive. That authorization now reads that grants shall be made without regard to matching funds provided by recipients. The Department believes that the education of promising new agricultural scientists and professionals can and should be a shared responsibility. By deleting these words, we could encourage the state and private sectors to contribute resources to the program and, thereby, expand the numbers of new graduate students enrolling in targeted shortages areas.

Mr. Chairman, this completes my prepared statement, I will be pleased to respond to any questions you may have.

STATEMENT OF
DR. JOHN PATRICK JORDAN
ADMINISTRATOR
COOPERATIVE STATE RESEARCH SERVICE
U. S. DEPARTMENT OF AGRICULTURE

Mr. Chairman and Members of the Subcommittee, I am Dr. John Patrick Jordan, Administrator of the Cooperative State Research Service, the Science and Education agency through which Federal research funding and planning is accomplished on behalf of the Department of Agriculture with the 52 State agricultural experiment stations, the 17 Colleges of 1890 including Tuskegee Institute, 62 independent Schools of Forestry and 26 Colleges of Veterinary Medicine. Most of these institutions are associated with Land-Grant universities. You have already heard from a number of the constituent organizations.

I would like to speak to three charter issues, specifically:

- The relationship of the agency to the needs assessment report and its subsequent impact;

- The biotechnology initiative which, if funded, will be administered through the Office of Grants and Program Systems within the CSRS budget; and

- Higher education and the role that research, funded at least in part by the agency through the universities, fulfills in providing highly skilled scientists and technicians to meet the needs of agriculture in the 1990s and beyond.

1. The Needs Assessment Study provides a quality knowledge base against which program planning and budgeting by the State agricultural experiment station system, including all of the units identified above, can be done cooperatively. By that I mean cooperation between the State agricultural

experiment station system and research agencies within the Department of Agriculture, particularly the Agricultural Reserch Service, the Economic Research Service, and the Forest Service.

The State agricultural experiment station system has engaged in cooperative planning with the U.S. Department of Agriculture and with neighboring States for many decades. Such a system was formalized with the establishment of the Regional Research Program which required the submission of coordinated proposals to the Administrator of the Cooperative State Research Service for approval. Subsequently, a broader range of program planning was put into motion as a result of the 1966 National Plan for Agricultural Research which was done cooperatively between the National Association of State Universities and Land-Grant Colleges and the U.S. Department of Agriculture.

From that 1966 Plan emerged a Memorandum of Understanding between the two organizations to form the Agricultural Research Planning Committee (ARPAC) initiating the 5-year projection system which is used in the current system. In fact that 5-year projection system was formalized in the Food and Agriculture Act of 1977 and is fully operative today.

The key issue from the point of view of the agency is to develop the 5-year projections based on the Needs Assessment Report and the 5-year plan and, thus, establish a quality fit. Deficiencies can be brought to the attention of the system through the National Agricultural Research Committee of the Joint Council on Food and Agricultural Sciences.

Each organization receiving funding through the Cooperative State Research Service has received multiple copies of the Needs Assessment Report and the 5-year Plan which is driven by the Needs Assessment Report. Consequently, the 1985-89 projections should be even more realistic than in the past since they will be related more closely to the Needs Assessment Report and the 5-Year Plan. However, the individuals that coauthored most of the articles in the Needs Assessment Study have been deeply involved in the regional and national planning system for agricultural research and, thus, even the projections that were made for 1983-87 are quite close to being on target. Mr. Chairman, in essence the system has been very responsive in recent years to the demonstrated needs of the agricultural industry of America.

One of the sub-headings in the charter under the "Impact of the Needs Assessment Study" is pesticide use. It relates to the public concern about the use of pesticides in agricultural production. There are a number of programs and projects funded at least in part by the Cooperative State Research Service that speak to this issue. The safe and effective use of chemicals in agriculture remains an important element of the research programs of the State experiment station system. We are proud of the joint efforts with the Extension Service, the Agricultural Research Service and the private sector in developing crop and livestock production systems that will yield commodities that are safe for consumers and the environment, and at the same time avoid excessive losses due to pests. National and regional Integrated Pest Management (IPM) efforts are backed by sustained programs of basic and applied research, including a large effort in biological control. A strong Federal-State pesticide impact assessment program continues to be an effective mechanism that is responding to current pesticide needs and issues.

2. Biotechnology is one of the most exciting frontiers that agriculture has had the opportunity to participate in for a long, long time. Simply stated, biotechnology is the application of technology advances to improve biological performance. The biotechnology committee of the Division of Agriculture, National Association of State Universities and Land-Grant Colleges has defined biotechnology as "the use of living organisms or their components in industrial processes." They point out that this is not new to agriculture but the impetus for greatly increasing the impact of biotechnology on food, fiber, and forest production, processing and utilization is really the exciting new frontier. Laboratory work in this arena has been done for several decades; now the opportunity to put it to work in the real world provides an ever increasing horizon. Two particularly good examples may be helpful.

(a) Cloning of calves

The asexual reproduction of genetic identical calves was developed at several State agricultural experiment stations.

Embryos are collected non-surgically six and seven days post estrus from superovulated donor cows. Unfertilized ova are also collected to provide a host shell for one-half of a split embryo.

Embryos are kept alive in a balanced salt solution enriched with serum and antibotics. Prior to microsurgical splitting they are placed in a small drop of medium covered with paraffin oil in a culture dish. While observing the embryo at 100x magnification through a microscope, the zona of the unfertilized ovum is cut. The contents of the ovum are evacuated leaving an empty shell. In similar manner the embryo is then bisected and one-half is removed and placed in the emptied shell. The two half embryos are then cultured for an hour or two to allow growth and reorganization. Following evaluation the embryos are then non-surgically transferred into recipient cows resulting in genetically identical twins.

Some of the practical applications of cloning are to be able to produce identical twins which will allow livestock breeders to rapidly increase their genetic pools; provide a larger number of possible pregnacies from donor cows that do not respond well to superovulation treatment; allow transfer of one-half of an embryo while the other half can be frozen for later implant; allow quicker return on investment; decrease the average cost per pregnancy, decrease the number of donor cows needed for transfer, and increase the gain from a specific genetic mating.

(b) Ice-nucleating gene.

Much frost damage to plants is caused by "ice-nucleation active" bacteria. The microscopic bacteria promote the formation of ice crystals. Plants covered with them freeze and are damaged or killed at temperatures as much as 9 degrees Fahrenheit higher than plants without them. One of the chemical products of one strain of the bacteria acts as a starter crystal around which frost can form.

Through experimentation, the genes that give bacteria the ice-nucleating ability have been isolated. Using recombinant DNA techniques, the gene sequence is excised leaving the bacteria otherwise identical. The engineered bacteria, when applied to crops will replace their ice-nucleating brethren, lower the plants' freezing point and thus prevent frost damage. This process could save U.S. farmers up to $1 billion a year on losses due to frost damage.

Recombinant DNA, or "gene splicing" techniques, initially found practical use in the manufacture of pharmaceutical products like insulin and human-growth hormones. But agriculture can certainly build upon this technology. With genetic engineering, plants may be able to provide more nutrition, repel insect pests or survive in salty water. Engineered microbes may someday help wheat plants provide their own nitrogen from the soil or combat specific diseases.

Recently U. S. District Court Judge John Sirica granted a preliminary injunction to prevent the "ice-nucleation" experiment from being conducted by the California Agricultural Experiment Station. All that Judge Sirica has really called for is proof that environmental concerns and the safety issues are adequately addressed. The Department of Agriculture has felt that the Recombinant DNA Advisory Committee (RAC), the National Institutes of Health has been a committee fully capable in terms of the talents and expertise of the people on that committee to make such judgments. It may be that the body politic will insist on something more than that.

3. The final issue I would like to address is the issue of the development of human capital to be utilized within the agriculture system, particularly with

respect to Research, Extension, and Teaching needs for the future. The data here are irrefutable; there is a net loss of 15 percent between those joining agriculture and those leaving agriculture in the professional ranks today, the latter due principally to retirements. The record reflects, however, that the system provides nearly 13,000 graduate students with at least partial funding. Of those, three-quarters are students studying at the Masters level and one-quarter at the doctoral level. Students at the Master's level may progress to the doctoral level but approximately two-thirds of them go on to be professional laboratory technicians, high school teachers of science, or work in the agricultural industry.

Support for graduate students through CSRS and the State agricultural experiment station system, however, provides funding only for students to do research and does not provide funds for teaching experience or teaching fellowships. On the other hand, CSRS and the State experiment station system do provide funding for a reservoir of people who can, with proper additional training, become teachers in the college and university system. CSRS is a strong supporter of the higher education program within the U.S. Department of Agriculture. It will do everything it can to assist in the coordination and strengthening of the reservoir of human capital available to conduct agricultural research, extension, and teaching activities, and to provide well trained individuals for the agricultural industry.

Mr. Chairman, I will of course be pleased to respond to any questions.

STATEMENT OF

DR. MARY NELL GREENWOOD

ADMINISTRATOR

OF

EXTENSION SERVICE

U. S. DEPARTMENT OF AGRICULTURE

Mr. Chairman and Members of the Subcommittee. I appreciate the opportunity to participate in the continuation of the oversight hearings on agriculture research, teaching and extension. Your hearings have given the Extension community an opportunity to demonstrate the historic effectiveness and future opportunities of the Cooperative Extension System.

Progress. Since the hearings on Cooperative Extension were initiated in March, 1982, significant strides have been made in resolving issues associated with the system. Actions include:

- Issuance by the Joint USDA/NASULGC committee of recommendations on "A Perspective for the Future of the Cooperative Extension Service." This is frequently referenced as the "Extension in the 80's" report.[1]
- Internal and external reviews conducted of the Federal partner, resulting in concensus on the functions and future directions for Extension Service, USDA, described in "Challenge and Change: A Blueprint for the Future." [1]
- A nationwide accountability and evaluation system designed and implemented.
- Interactions and linkages with USDA research, action and regulatory agencies strengthened.

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[1] Recommendations from these documents were the primary focus of the June 3, 1983, hearing before this Subcommittee so are not addressed in this testimony.

The Extension in the 80's report reaffirms the mission of the Cooperative Extension System which is to disseminate, and encourage the application of, research-generated knowledge and leadership techniques to improve American agriculture and to strengthen this nation's families and communities. The need to restore profitability to agriculture, sustain the productive capacity of our natural resource base and strengthen export markets for agricultural and forest products are some of the issues that underscore the fact that the timely dissemination and application of research knowledge is essential to the basic survival of our Nation's number one industry.

Accountability and Evaluation System. As noted earlier, several initiatives discussed at previous hearings are now operational and producing positive results. The new national accountability and evaluation system for Cooperative Extension programs became operational October 1, 1983. Key ingredients of the system are a four-year planning cycle, reduced and improved reporting procedures, and increased and more effective evaluation at both the state and national levels.

The four-year programs of work in each state focus on major program efforts, including objectives and projected impacts for each major program. The planning process actively involves citizens in the counties and states across the nation in identifying and prioritizing needs. Major programs are then developed to address these needs within the limitation of resources. The system also links reports of program accomplishments to projected programs of work.

Another ingredient of the system is expanded program evaluation. Working with our state and county partners through the National Extension Accountability and Evaluation Policy Council, we have identified and implemented national evaluation studies dealing with five major extension education programs. In addition, states have, or will, be initiating more than 200 studies, some of which are multi-state in scope.

The national studies now underway focus upon integrated pest management, renewable natural resources, financial planning and management, volunteerism and leadership development. These studies, designed to measure social, economic and environmental impacts, will also provide information on program participation, program management practices, the effectiveness of different program delivery methods, and the research/extension/action agency linkages. Results from these studies will provide Extension nationwide with information for improving both the effectiveness and efficiency of programs and will give us the capability to modify program policies where the need occurs.

This accountability and evaluation system is an "online" source of information on major programs, reports of accomplishments and evaluation studies that is accessable to all three partners through our national communication network. This comprehensive system will provide all levels of Cooperative Extension with one of the most powerful program management tools that it has ever had.

1862/1890 Relations. As you know, 16 states have both 1862 and 1890 land-grant institutions that are involved in conducting Cooperative Extension programs. In accord with the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended by the Agriculture and Food Act of

1981, the respective institutions in each of these states maintain comprehensive program plans, which were updated in 1983. Representatives of these institutions also collaborate and jointly submit to USDA their four-year programs of work. The development of both the comprehensive and four-year program plans provide viable mechanisms for coordination and cooperation in the delivery of Extension programs and effective utilization of resources for addressing the educational needs in each of the 16 states.

Addressing Critical National and State Needs. The recently completed Needs Assessment for the Food and Agricultural Sciences, under the direction of the Joint Council, will provide guidance for national program priorities. One of the common threads that was woven through this Needs Assessment was the need for the development and adoption of alternative production technologies to maintain a profitable and productive agriculture that provides the food, fiber and forest products for both domestic and international markets while maintaining the integrity and productive capacity of the Nation's natural resource base. To meet these needs will not only require new technological developments but also a dynamic system that both identifies critical national and state issues and needs and rapidly transfers current and new technology to users for adoption.

The Extension system has made significant efforts over the last decade to target and redirect programs. As identified in the "Needs Assessment" and "Extension in the 80's," the Cooperative Extension System programs of work for the next four years address high priority issues, such as crop and animal production efficiency, financial and marketing management, human nutrition, leadership development, etc. Among the programs to receive increased emphasis are soil and water conservation, forest and rangeland management, processing, marketing and distribution, and agricultural and natural resource policy. The increased emphasis for these programs will come primarily through the redirection or reallocation of present resources.

Interface with Research/Action/Regulatory Agencies. The importance of translating new and revolutionary scientific research to enhance agricultural productivity in this country with minimal new resource allocations, dictate an even stronger collaboration between research and extension. Extension programs, in order to be effective, depend upon an adequate base of research-generated knowledge.

Powerful linkages exist within our cooperating institutions between researchers and extension specialists, with some having joint appointments. We are aggressively pursuing stronger linkages with federally supported research laboratories. Recent examples include incorporating current ARS research findings into our nationwide electronic communications network for rapid transmission to extension workers across the country; headquartering an extension worker at the Forest Service National Forest Products Laboratory in Madison, Wisconsin, to design mechanisms for identifying and incorporating new research findings into extension programs; initiating a shared/joint appointment between Economic Research Service and Extension Service in the area of community structures and decisionmaking and a comparable arrangement projected in public policy; Extension Service leadership for technology transfer with the Federal Laboratory Consortium.

In addition, the Cooperative Extension system, as cooperator, mediator and educational leader in an age of limited resources serves as an important conduit for Federal and State action/regulatory agencies in educational programming with producers, consumers, and local and community leaders. For example, we are cooperating with USDA's Food Safety and Inspection Service to help livestock and poultry producers avoid drug and chemical residues in slaughtered animals; collaborating with Federal Crop Insurance Corporation in helping farmers make wise risk management decisions about crop insurance utilization; supporting the Secretary's initiative in food and fitness with the State Extension Services taking the lead in information dissemination on food, nutrition and exercise and their effects on health and well-being; and shared positions where either expertise or liaison is needed in critical program areas, e.g., conservation tillage and rangeland management.

Future Challenges and Opportunities. As we continue to respond to the recommendations in the "Extension in the 80's," findings from the very substantive Needs Assessment by the Joint Council on Food and Agricultural Sciences, and important views expressed by user/advisory groups at all Extension levels--national, state, county--Extension will continue to initiate program and administrative improvements to be on the "cutting edge." It is my expectation in the coming months, in concert with my federal and state colleagues, to:

1. Continue pursuits to capitalize and utilize existing and new electronic technologies in the delivery of Extension programs. (This topic was addressed in the testimony by Dr. Henry Wadsworth, Director, Purdue University, and Chair of Extension Committee on Organization and Policy.)

2. Institute improved systemwide processes for identifying and supporting national and regional program innovations, including emerging technologies. As one component of the process, we have sought proposed initiatives from our national program staff. We are in the process of selecting a number of these initiatives for implementation. It is anticipated that these initiatives will place our national program staff in a stronger catalytic role for the diffusion of new technologies.

3. Develop an efficient, timely process for identifying critical national and regional programmatic issues to be addressed. The Cooperative Extension Service has an excellent record for needs identification at local and state levels. From my perspective, this capability can be strengthened at the regional and national levels.

In closing, Mr. Chairman, as we continue to move forward in our efforts to strengthen the Cooperative Extension System so it will continue to be a vital force across this entire Nation, we must be mindful of those characteristics of the system that have allowed it to be a unique achievement in American education. These characterists include the tripartate partnerships, the involvement of people in our planning processes, adequate flexibility for programs to respond to changing conditions, the research based information system, the ability to work effectively with private sector resources and our nationwide system of adult and youth volunteers working with Extension professionals to deliver programs.

On behalf of my colleagues across this country, thank you for the opportunity to participate in these hearings.

STATEMENT OF
DR. KEITH R. SHEA, ASSOCIATE DEPUTY CHIEF FOR RESEARCH
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Before The
Subcommittee on Department Operations, Research, and Foreign Agriculture,
Committee on Agriculture
United States House of Representatives

Concerning Forestry and Related Renewable Resources Research in USDA

June 13, 1984

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

It is a pleasure for me to join with my Departmental colleagues appearing before you today. The Forest Service is an active participant in the research efforts directed by the Assistant Secretary for Science and Education. We maintain close liaison with Assistant Secretary Bentley's office. We believe that forestry and related renewable natural resources have been well served by the long-term nature of this science and education partnership within the Department of Agriculture.

Forestry is big business in the United States. The total forested land base in the United States is about 750 million acres or about one-third of the total land area of the country. Of this, about two-thirds--480 million acres--is occupied by "commercial" forests, i.e., land which is capable of growing trees at sufficient annual volume to have commercial value. The forest products industry adds about $62 billion a year to the United States economy and represents about 7 and one-half percent of the total value added in all of the Nation's annual manufacturing activities. Thus, about $1 of every $13 of manufactured value added comes from the forest products industry. About 1 out of every 11 jobs in the Nation in one way or another is associated with the forest products industry. Additionally, the Nation's forests are important for grazing, for recreation, for soil and watershed protection, as habitat for wildlife, as a major source of water for the Nation's cities and rural areas and for esthetics.

Forestry research conducted or supported by the Forest Service in fiscal year 1984 amounted to $108 million. The 61 forestry schools of the Nation have a research budget approaching $80 million from all sources combined. These two programs---of the Forest Service and of the 61 forestry schools---account for the vast bulk of publicly supported forestry research in the United States. Thus, it is important that these two programs be closely coordinated and integrated.

Forest Research Planning. The forestry schools and the Forest Service have taken a number of steps to integrate their research activities. The most recent product of this effort is the 1980-1990 National Program Of Research For Forests And Associated Rangelands. Forest Service planning is done pursuant to the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA): forestry school planning is done under authorities contained in the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended. These two planning efforts have been merged in the document cited above. I should also add that the next joint planning effort is already underway and should be completed in calendar year 1985.

In addition to these national planning efforts, more detailed collaboration and coordination is done through four regional planning groups, whose planning areas coincide with those used by all other science and education in the Department of Agriculture. Under these regional groups, we address more specific and localized planning and coordination efforts that are appropriate to the specific regions of the country.

Research Evaluation. About 5 years ago, the Forest Service and the forestry schools looked again at the need for a better evaluation of research. The aim of that effort was to improve priority-setting and to evaluate the outcome of a variety of research. The results of this study, Criteria For Deciding About Forestry Research Programs, have been useful in establishing research priorities. Since that time, the Forest Service and the forestry schools have undertaken a series of specific studies of what have been and what are likely to be the payoffs from forestry research. It is important to note that we in forestry research have borrowed heavily from the evaluation methods and techniques that have been developed for ~~of~~ agriculture in general.

Basic Research. The forestry sciences are as concerned about the need to understand basic processes as are other sciences in agriculture. Because of this concern, the Forest Service and the forestry schools undertook an examination of basic research needs in forestry and published in 1982, Our Natural Resource: Basic Research Needs In Forestry And Renewable Natural Resources. Five primary areas of scientific inquiry were identified in this study: (1) basic biology including biotechnology, (2) ecological processes, (3) forest engineering and material science, (4) economic and consumer benefits, (5) forestry managerial sciences. These five areas of basic inquiry are essential both for economic and social benefits. The Forest Service has directed approximately $1 million into various biotechnology research projects. We intend to place more emphasis in these promising areas in the future.

Regional And National Reviews Of Research. The forestry schools and the Forest Service, as provided by in the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended, have embarked on a series of reviews of important science and education activities related to forestry. One review concerns utilization of forest products and is conducted under the principal leadership of the National Forest Products Association representing the forest industries. Each year, a broad cross-section of industry and other users examine in detail the research programs of the Forest Service and the forestry schools related to improved utilization of wood. This review provides information to all users of forestry research in connection with wood utilization and has the additional benefit of fostering relations between the public and private sectors. In addition, technology transfer, which is the more rapid use of information to solve problems, is greatly enhanced.

Other research reviews include a review of the national forest inventory which is a periodic assessment of the conditions of forest lands of the Nation. Another research review which has just been completed involved the integration and coordination of growth and yield forecasting which are very important to public and private forestry, particularly in the South. In the years to come, other reviews will be undertaken.

And finally, Mr. Chairman, I would note that the Joint Council on Food and Agricultural Sciences has identified forestry research as one of its high priorities for examination. The Joint Council recognizes that there are a number of opportunities in forestry research that need additional attention including:

Basic Research/Biotechnology. Forestry probably will reap the largest return of any crop from the application of biotechnology--first, because there is so much potential improvement awaiting our discovery, and secondly, because tissue culture and gene-splicing technologies offer a way to shorten the long period between generations of forest trees.

New Program Direction. Areas of emerging emphasis will include applications of economics to alternative forest management plans and investments; improved technologies for forest regeneration and forest products utilization; protection of the basic productive potential of forestlands through reduction of adverse impacts of forest land management; and forest pest management.

Education: Recruitment and Retention. Applications and enrollments in undergraduate and, to some extent, graduate programs in forestry and related fields have declined. Renewed efforts will be required to recruit and retain high-quality students who will be the resource managers and scientists of the future, especially in the face of the increasing average age of the current forestry scientists.

Information Packaging and Delivery Systems. There is still much to be done to improve the translation and transmission of new concepts and technology to the ultimate user. New electronic communications technology can assist in this task.

International Activities. North America and the United States have the productive capacity to be the "wood basket" of the world. To realize that capacity will require development of technologies so as to lower costs of products and increase demand on world markets. This also will entail development of technologies to use efficiently a vast reservoir of underutilized hardwoods growing in the United States.

In addition, technical exchanges with other countries make it possible to share experiences and data, exchange germplasm; and otherwise share information that can improve the efficiency of forest production.

Institutional Structure. The institutional structure and interrelationships of participants in forestry research, education and technology transfer are complex, highly distributed, and made up of an extremely heterogeneous set of disciplines and units. The process for informing new participants, determining if the institutions have the right number and kind of participants, and seeking opportunities for improving institutional performance must be constantly examined.

Resources and Funding Availability. Mr. Chairman, the next round of research planning by the forestry schools and the Forest Service will be completed early in 1985. At that time we will be prepared to go into still more detail about opportunities and needs associated with publicly supported forestry research in this country. The several points brought out in the Joint Council discussions about forestry research might also serve as a basis for review by this Committee and by others.

Mr. Chairman, this concludes my testimony. I would be happy to respond to the Subcommittee's questions.

GEORGE E BROWN JR CALIF
CHAIRMAN

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MINORITY CONSULTANT

May 22, 1984

Memorandum

TO: Members, Subcommittee on Department Operations, Research, and Foreign Agriculture

FROM: George E. Brown, Jr.

The briefing book which accompanies this memo provides useful background on the issues to be discussed at the hearings on agricultural research, extension and higher education on June 6, 7, 12 and 13. The book was prepared by Kennan Garvey, on detail from USDA, with considerable input from Skip Stiles, Subcommittee Staff Consultant.

Each section of the book addresses a section of the charter. A briefing paper in each section restates the charter language and provides additional background. Relevant excerpts from various documents follow each briefing paper.

Comments we have received on the draft charter have generally provided observations on the issues. Since the charter is intended to stimulate such dialogue, we have decided to finalize the draft charter without change.

We have scheduled a briefing session for your staff on June 4 at 3:00 p.m. in 1336-A Longworth Building to summarize the briefing book and answer any questions on the upcoming hearings.

The hearing schedule is attached. Note that the session on June 7 is now scheduled to begin at 9:45 a.m. This was delayed slightly due to my scheduled testimony before another Subcommittee.

George E. Brown Jr.

Tentative Schedule

Agricultural Research, Extension and Higher Education Hearings

June 6, 1984 - 1:30 p.m.

Biotechnology - USDA program plans, regulatory concerns, and public benefits.

June 7, 1984 - 9:45 a.m. and 1:30 p.m.

Needs Assessment - implications of the Needs Assessment for priority-setting, pesticide use, and technology and farm structure.

June 12, 1984 - 1:30 p.m.

Extension in the 80's follow up - accountability issues, formula change, and computer technology.

Higher Education issues.

June 13, 1984 - 9:30 a.m.

USDA witnesses. ARS redirections and USDA views on all issues.

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BIOTECHNOLOGY

USDA Plans

I. Draft Charter Language

The system has largely succeeded in establishing the need for USDA support of agricultural biotechnology research. The greatest gains from biotechnology will come when scientists in traditional disciplines are trained to understand the potential contribution of biotechnology to their work, and when scientists in the new biotechnology disciplines understand how their efforts contribute to the existing knowledge base. The USDA budget material emphasizes the Department's ability to link the new effort to the existing knowledge base. USDA could play a unique Federal role by structuring the grant program and other activities to ensure this.

The National Science Foundation (NSF) plant biology program has been growing steadily and is able to fund projects at about twice the annual level of USDA funded projects. Both agencies support plant biotechnology research. The large McKnight Foundation grants have encouraged interdisciplinary projects emphasizing graduate student research. The Federal government currently lacks such a program in plant biology.

Issues. How can USDA structure the grant program to fill a unique leadership role? How do the USDA and NSF programs currently differ? What are the appropriate and actual public and private roles in biotechnology? Would a dedicated Federal data base, like the Human Nutrition Research Information Management System, assist planning and coordination of Federal agricultural biotechnology activities?

II. Additional Background

An increasingly widespread consensus in the agricultural scientific and policy community resulted in a $28.5 million FY 1985 increase request for USDA biotechnology competitive research grants. Reductions in other popular programs will make it difficult to obtain this increase. Competitive Research Grants were first funded in 1978 at $15 million and have only grown to $17 million in 1984.

Biotechnology is a broad term covering a number of technologies, including genetic engineering, that allow scientists to manipulate basic cellular and genetic processes. Traditional breeding programs involve whole organism crosses, which often result in compromises. The new biotechnologies permit individual genes to be modified. This could greatly speed plant and animal improvements. Bacteria are relatively simple genetically and easy to manipulate, as evidenced by the recent creation of a modified bacteria designed to lower the freezing temperature of plant leaves by several degrees. Plants and animals are much more complex genetically and harder to manipulate. Scientists have identified about 60,000 genes in higher plants and the total is probably in the millions. Most important traits are governed by the interaction of many genes.

USDA's ability to establish leadership in agricultural biotechnology research will influence its science budget in the coming years. If USDA increases are not provided by the Congress, future growth may shift to NSF, where basic plant research increased by $28 million (90%) between 1980 and 1985. USDA must establish its unique strengths if it hopes to provide leadership for agricultural biotechnology.

USDA has not publicly discussed plans for allocating the funds and managing the greatly expanded program in FY 1985. The following issues could be clarified at the hearing:

(1) The allocation between plant and animal biotechnology research.

(2) The relative research emphasis on:

  (a) basic gene function and expression (an area which NSF emphasizes), or
  (b) identification and manipulation of genes controlling traits in commercially important crops.

(3) Allocation of funds to single investigator grants, multidisciplinary grants, and the amount allowed for new equipment under each type of grant.

(4) USDA's plans for staffing the expanded program.

(5) The need for a dedicated data base linking USDA, NIH, NSF and non-Federal plant and animal biotechnology research.

These issues are discussed in the following sections.

ALLOCATION BETWEEN PLANT AND ANIMAL RESEARCH. Basic animal research has never been funded under Competitive Research Grants. In FY 1985, the Administration is requesting $4.5 million for basic animal reproduction research, separately from the $28.5 million biotechnology package. The budget material states that some of the biotechnology funds will also be for animal research.

Considering the limited funding, greater payoffs might be obtained by focusing the funds on one or two problem areas in plant biotechnology. This would also avoid diverting scarce staff resources to cover a new animal science area. Placing greater priority on plants would be consistent with supply/demand projections in the Needs Assessment (ref. separate briefing paper on this topic).

RELATIVE RESEARCH EMPHASIS. Dr. Hess tried to distinguish the separate roles of NSF and USDA at the DORFA hearing in February. He gave the example of USDA searching for specific genes for disease resistance in commercially important crops, while NSF tries to answer the more fundamental question of how genes are activated at a particular time and place. The lines of demarcation between USDA and NSF research are often more fuzzy than the example indicates. Some overlap is not bad considering the overall inadequate funding. However, USDA and NSF should explain their relative priority areas and coordination mechanisms.

Research emphasis also raises the issue of public and private roles. It is often said that private firms will not undertake long term basic research on gene structure, function, and expression. But the larger firms appear to be doing this type of research, though the results may not be quickly shared. USDA needs to determine a unique Federal role. If the USDA emphasis is on identifying useful genes, it might target problem areas where the commercial payoffs are limited even though the social benefits are large. For example, a chemical company may not place a high priority on increasing pest or disease resistance. A private breeding company might concentrate its biotechnology research on yield-increasing efforts, rather than increasing genetic diversity.

TYPE OF GRANTS. To date, USDA and NSF competitive research grants have gone exclusively to a single principal investigator. Little money is available for new equipment; in fact, availability of equipment is given a positive weight in judging proposals. Expanded funding will permit more diversity in types of grants. USDA might be encouraged to allocate some money to multidisciplinary grants that emphasize cooperation between graduate students and post-doctoral fellows in different disciplines. This could help make up for the deficiency in USDA higher education funding. It could also encourage cooperation between the traditional agricultural sciences and the new biotechnologies. USDA claims a unique ability to foster this type of exchange. The McKnight Foundation grants might serve as a model for this type of program (ref. attached material). The Users Advisory Board and the NASULGC Committee on Biotechnology have recommended funding for multidisciplinary grants.

USDA might also consider increasing its average grant size and duration. Current grants are about $35,000 annually. About 20% goes for indirect costs and is unavailable to the researchers. NSF grants average about $65,000 annually. USDA grant categories have been funded at about $4 million each. NSF attracts more investigator interest by funding categories at about $10 million.

If the average grant size is increased, investigators could be encouraged to include requests for modern equipment necessary for efficient biotechnology research. The November 1983 NASULGC study "Emerging Biotechnologies in Agriculture" included a request for $24 million specifically for equipment grants. The Administration budget did not include this. Lack of funding for equipment limits the number of schools that can compete for research grants. Title XIV currently lacks specific authorization for competitive equipment grants.

USDA STAFFING PLANS. USDA may have difficulty operating an expanded competitive grants program in FY 1985. Science and Education agencies' personnel ceilings are being reduced each year. The Office of Grants and Program Systems (OGPS), which operates the Competitive Research Grants program, has no separate budget account or personnel ceiling. Even if OGPS could be allocated more staff positions, the agency will not know the Congressional funding level for FY 1985 until it is too late to hire additional staff for the next grant cycle.

Expanding the peer review panels might also be difficult. These panels are composed of national experts who review the research proposals. Since these are advisory committees, OGPS must compete with all other USDA agencies for new funds. Funding for advisory committess has not increased since FY 1983 when the Appropriations Act set up a separate account for these committees.

DEDICATED DATA BASE. USDA's Current Research Information System (CRIS) contains summaries of all USDA and State Agricultural Experiment Station research projects. Biotechnology research is difficult to search on CRIS. Also, CRIS does not cover biotechnology research at many institutions. These gaps make it very difficult to track the overall public effort in agricultural biotechnology. Scientists do not have an opportunity to quickly review an on-line data base to stay current on related research.

The Users Advisory Board has recommended USDA participation in a Federal government biotechnology research information system. The Human Nutrition Research Information Management System (HNRIMS) required by Section 1427 of Title XIV is a good example of a dedicated data base. However, due to the slowness of updating projects on CRIS and HNRIMS, the data bases are of more use to policy officials than to bench scientists. The ideal would be a data base which scientists could immediately update as new developments occur (e.g. just prior to publication), although such a data base would lack financial information. The data base would then become useful to other bench scientists. Many problems would have to be overcome in setting up such a system and USDA and NSF should offer views on the usefulness of a biotechnology data base at the hearing. ARS is already collecting abstracts of all research manuscripts but has not considered putting them on-line for other scientists.

The following pages contain additional material on these issues.

Excerpts from "Genetic Engineering of Plants-
Agricultural Research Opportunities and
Policy Concerns"

Board on Agriculture, National Academy of Sciences 1984

Multidisciplinary Training

Not only will plant biotechnology require more scientists, it will require scientists having different, broader training. "The most rapid gains in applying this technology to plant and animal science will come when applied and basic sciences collaborate in common research programs," said Charles Hess, dean of the College of Agriculture and Environmental Science at University of California at Davis. "For example, the combination of molecular biologists with plant breeders and plant pathologists will accelerate the genetic engineering of disease-resistant plants." Hess suggested that USDA provide additional funds through its Competitive Grants Program for such collaborative biotechnology research.

Whether working in the laboratory or the field, scientists with backgrounds in agronomy and molecular biology will need to be able to communicate. Thus, a crucial component of the training of both future agricultural scientists and molecular biologists will be a grounding in the related disciplines.

Such training has been sorely lacking to date. According to Philip Filner of the ARCO Plant Cell Research Institute, "In my experience recruiting and interviewing many young scientists in the last two years, I have the feeling that they have struggled very hard to master the jargon of their field of expertise and have then become addicted to it. They are not very good at communicating their ideas. There is a need to improve their ability to understand, appreciate, and use the main ideas of complementing fields. I've encountered graduate students who are working on the structure of mitochondrial DNA who question the necessity of understanding the details of energy metabolism in the mitochondria. Similarly, Ph.D.s working on a bacterial virus may be almost totally ignorant of animal or plant viruses. They simply don't understand or appreciate what others do and how they do it. This is a very serious disadvantage when they come into an industrial environment where the emphasis is on collaboration toward a common goal."

Filner suggested that students of plant molecular biology also learn plant physiology and breeding. Kenneth J. Frey, an agronomist at Iowa State University, added that plant breeders must gain a familiarity with molecular biology.

In some cases, it may be sufficient to simply supplement major studies in one field with coursework in another. In other cases, more extensive multidisciplinary training may be necessary. A number of scientists trained in the molecular biology of microbial or animal systems are now being drawn to plant genetic engineering. An opportunity exists to attract more students to plant research through special workshops in plant biology and postdoctoral research positions to work on plant science and agricultural problems.

THE MCKNIGHT FOUNDATION
410 PEAVEY BUILDING
MINNEAPOLIS, MN 55402

FOR RELEASE
OCTOBER 29, 1982

For additional information contact -
RUSSELL V. EWALD
EXECUTIVE VICE PRESIDENT
612-333-4220

The Directors of The McKnight Foundation today announced the establishment of the MCKNIGHT AWARDS FOR INDIVIDUAL RESEARCH PROJECTS IN PLANT BIOLOGY and the MCKNIGHT AWARDS FOR INTERDISCIPLINARY RESEARCH PROJECTS IN PLANT BIOLOGY. Both awards programs are for a ten year duration and together will provide research and training funds totaling $18,500,000 over the ten year period. Brochures describing each program are attached.

The Foundation's decision to develop these programs is twofold: the result of a planning program initiated in 1979 to review some thirty program areas for potential future development and funding with the selection in 1980 of this particular area for further development; and, the opinion of the Board of Directors' that the greatest impact on the anticipated world-wide food crisis can be achieved by initiating and supporting research programs designed for the education and training of promising researchers and future teachers in the basic agricultural sciences.

The research areas are:

a. Transfer of Gene Groups (non-conventional)
b. Cell and Tissue Culture
c. Photosynthesis/Stress
d. Gene Expression
e. Plant Growth Regulators
f. Host Parasite Relations
g. Environmental Stress
h. Partitioning and Transport
i. Biological Control and Co-evolution

The Foundation is indebted to the members of the Review Committee for their assistance in designing this program and for their commitment to provide the major review process in selecting awardees. The members are:

Dr. Richard S. Caldecott (Chairman)
Dean, College of Biological Sciences
University of Minnesota

Dr. Hans Kende
Professor, DOE Plant Research Lab.
Michigan State University

Dr. Richard Baldwin
Vice President for Research
Cargill Company

Dr. Oliver Nelson
Brink Professor of Genetics
University of Wisconsin

Dr. Mary Clutter
Section Head, C.P.B.
National Science Foundation

Dr. Robert Rabson
Dir., Biological Energy Research Div.
United States Department of Energy

Dr. Milton Zaitlin
Prof., Plant Pathology Department
Cornell University

McKnight Awards for Interdisciplinary Research Projects in Plant Biology

The McKnight Foundation announces a series of awards designed to stimulate research and training in basic plant biology as it relates to agriculture. The purpose of the Awards is to stimulate new efforts and alliances and to encourage continuing efforts of established groups which emphasize training as a major component of their research.

The McKnight Awards will be few in number and will be granted to groups of investigators whose programs are anticipated to be of outstanding potential significance. Awards will be for a minimum of three years with continuation contingent upon a positive re-evaluation of the program. Funding will be flexible, providing up to a maximum of $300,000 per award for each year. Indirect costs will be limited to 10 percent.

These awards will permit approaches to research and training that are not presently possible through the usual granting channels. Thus, the awards will make available the resources necessary for interdisciplinary research initiatives that will place a major emphasis on training of pre- and postdoctoral students. Modest funding for a limited number of undergraduate students may be included as an incentive for them to enter careers in fundamental plant biology.

All applicants are asked to submit a preliminary pre-proposal to be received by October 15, 1982 (two pages in length). For those projects which the Review Committee judges to meet the objectives of The McKnight Foundation an invitation will be issued by November 1, 1982, to submit a full proposal by March 1, 1983. The full proposals which receive the Committee's recommendations will be funded June 1, 1983.

Requests for further information and instructions about applications should be directed to Mr. Russell V. Ewald, Executive Vice President, The McKnight Foundation, 410 Peavey Building, Minneapolis, Minnesota 55402.

THE McKNIGHT FOUNDATION
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[illegible]

McKnight Awards for Individual Research Projects in Plant Biology

The McKnight Foundation announces a program to provide awards to outstanding individual scientists who are conducting basic research in plant biology as it relates to agriculture. The primary purpose is to make research support available to gifted individuals who have conducted independent research for a period of more than two years but less than fifteen years following completion of postdoctoral studies. A secondary purpose is to support investigators who desire to undertake new initiatives in plant biology which may be beyond the scope of their previous endeavors.

The McKnight Awards will be 10 in number in the amount of $35,000 per year for a three-year period. Use of the funds is flexible to permit approaches to research and training that are not presently possible through the usual funding channels. Each awardee will be supported with an award of $35,000 payable to the sponsoring institution in 1983, 1984 and 1985. These awards are personal and their use is at the discretion of the awardee. Funds may be used for salary and direct costs but not indirect costs.

Applications will be evaluated by a Review Committee which will recommend candidates to the Foundation for appointment. The deadline for submission of applications is December 1, 1982 with the awards being effective March 1, 1983.

Requests for further information and instructions about applications should be directed to Mr. Russell V. Ewald, Executive Vice President, The McKnight Foundation, 410 Peavey Building, Minneapolis, Minnesota 55402.

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(9-13-82)

BIOTECHNOLOGY

Regulatory Concerns

I. Draft Charter Language

There is great uncertainty concerning the regulation of biotechnology products. This is a very complex area which merits separate attention. As an initial step, witnesses may offer ideas on improving the regulatory process for field testing and commercialization of new products.

Issue. What type of regulatory approval process for release of new organisms would protect the environment without destroying the potential of biotechnology?

II. Additional Background

Biotechnology will be the highest research priority over the next several years. The DORFA Subcommittee needs to be aware of the significant regulatory uncertainties governing the release of new organisms created by biotechnology research. Failure to provide an adequate regulatory approval process will leave the door open to continual court challenges, which may prevent promising new products from being used.

Up until now, biotechnology research has been regulated by the scientific community itself. This unusual approach is beginning to unravel as scientists develop new products that need to be field tested. Since biotechnology products are new life forms, there is a remote chance of a negative impact on the environment. This danger has always existed for any organism introduced into a new environment, as evidenced by the irresistible advance of gypsy moths over the past century.

University of California researchers now wish to field test a modified bacteria that will lower the freezing temperature of plant leaves by several degrees. If this bacteria thrives in the field, it will have tremendous economic benefits. The field testing is being challenged in court by environmental groups that believe the release did not receive adequate review. They charge that the National Institute of Health (NIH) Recombinant DNA Advisory Committee (RAC) that approved the release lacks expertise in ecological systems analysis. On May 16, Judge Sirica issued an injunction against release of the bacteria until the case can be heard (ref. attached article). The basic legal issue is whether the NIH RAC complied with the National Environmental Policy Act that sets forth review procedures for Federal actions affecting the environment. This decision could block field testing of biotechology products developed by Federally funded scientists for several years.

Two Subcommittees of the Science and Technology Committee conducted hearings on the safety issue last June and issued a report in February -- often referred to as the "Gore report." The major findings were:

(1) The risk of a harmful release is very small, but the damage could be great.

(2) Biologists and ecologists cannot predict the likely effects of a release with complete certainty.

(3) Current NIH RAC oversight is limited to research projects that receive Federal funding. Private firms' compliance is voluntary.

(4) The NIH RAC does not include members with an expertise in predicting ecosystem interactions.

(5) An interagency Advisory Committee is needed to broaden the participation in release decisions. EPA would be included.

(6) EPA should claim jurisdiction over all biotechnology products, using the very general authority in the Toxic Substances Control Act (TSCA) and FIFRA authority when pesticides are involved. (EPA is now working on a proposed rule.)

(7) USDA also has potential regulatory jurisdiction under APHIS statutes intended to control introduction of harmful organisms. GAO was asked to investigate the USDA jurisdiction.

The Sirica injunction and the EPA move to claim jurisdiction has unsettled public and private biotechnology researchers. Since the effects of a release on an ecosystem can never be known with certainty, a stringent risk assessment could keep many promising products off the market for years. Some researchers do recognize that a good Federal approval process is urgently needed to forestall court challenges.

The potential for court challenges and endless Federal review of each new product could begin to slow investment in biotechnology research. Congress might need to enact special legislation providing clear guidelines for regulating this new science area. This hearing will only provide for an airing of the issues. Alternatives could be investigated in more detail at future APHIS or FIFRA oversight hearings, perhaps after the GAO report is done.

Additional material is provided on the following pages.

U.S. Judge Halts Experiment in Gene Altering

By Philip J. Hilts
Washington Post Staff Writer

U.S. District Court Judge John J. Sirica yesterday halted the first experiment designed to take gene-engineered microbes out of the laboratory and test them in the open field.

Sirica granted a temporary injunction to stop a University of California experiment and all other experiments that "deliberately release" gene-engineered organisms into the environment. The court will conduct a full hearing later on whether the federal government violated the law in approving the experiments without fully assessing environmental impact.

"The case could be extremely important," said Jeremy Rifkin, the author and social activist who filed suit against the release of some possible frost-preventing genes into a potato field.

"It could be the key to starting a national debate. It will force the [National Institutes of Health] to reconsider how it is going to oversee biotechnology work in the United States," he said.

Rifkin, his Foundation on Economic Trends and other plaintiffs in the suit charged that the NIH, in approving the experiments, failed to consider the work's possible impact on the environment and therefore failed to comply with the National Environmental Policy Act, which requires such assessments before "major federal action".

David Dorinson, associate counsel for the University of California, said he would immediately appeal the decision, which could affect an entire

See GENES, A24, Col. 1

GENES, From A1

class of applied gene-engineering work.

"The court's ruling, if upheld, would have a devastating effect on the field of recombinant DNA research," Dorinson said. If the decision stands, it could be several years before this kind of biology, especially agricultural work, could be practiced in federally funded institutions in the U.S., he said.

Experiments affected by the ruling will be all gene-engineering experiments that are done with federal funds and put their final products into the environment—crops altered to resist disease or pests, for example, or microbes engineered to degrade sewage or toxic chemicals.

Since industry normally does not receive federal funds for its gene-engineering work, companies may continue extensive agricultural experiments, but most universities may not.

Sirica enjoined the government from "approving or continuing to approve the deliberate release of recombinant DNA" into the environment. Recombinant DNA refers to organisms that have had genes (deoxyribonucleic acid or DNA) altered or "recombined" in the laboratory.

The University of California experiment which triggered the court action was a field test intended to put specially engineered microbes on potato plants to protect them from frost.

The experiment had been tested successfully in the laboratory, and a 1-acre field near Tule Lake, Calif., has been planted for the test but not yet sprayed with the microbes.

The bacteria to be sprayed on the potatoes is Pseudomonas syringae, which exists on virtually all plants. It helps trigger the formation of ice on vegetation and thus causes millions of dollars of frost damage annually in this country.

In the tests, the syringae bacterium was altered by removing a section of its DNA—the section responsible for helping ice crystals form on plants.

The altered bacteria would be sprayed on the plants as soon as they sprout so that the "innocent" non-frost-triggering bacteria can take over the niche on the plant where the similiar, damaging bacterium used to preside.

In greenhouse versions of the experiment, the microbes gave the potatoes resistance to frost damage down to 23 degrees Fahrenheit. Potatoes usually begin to suffer frost damage at about 30 degrees.

Sirica said he would not decide the final case on scientific issues or the question of risk, but on matters of law—chiefly whether NIH's environmental assessment satisfied the environmental policy act.

But the suit was triggered by concern that the frost-prevention experiment and others could cause unforeseen environmental damage. The chief danger cited in the plaintiffs' affidavits was that the new bacterium would greatly change the relative numbers of frost-sensitive and frost-resistant plants and insects in the environment. It could reduce the populations of beneficial insects and plants or increase noxious ones inadvertently.

Steven Lindow, chief scientist on the California experiment, said he had done three years work in the lab, greenhouse and field, all of which show that there is little risk of the altered bacterium spreading or causing harm.

Oddly, a California biotechnology company which backed Lindow's work may proceed under the judge's ruling.

The company has applied to NIH to do field tests of the same frost-preventing bacterium.

FORESIGHTS Congressional Clearinghouse on the Future
February 1984

The Commercialization of Biotechnology

A new industry and its new technology may be outpacing current laws and regulations

Explaining recent lawsuits filed against the National Institute of Health's (NIH) Recombinant DNA Advisory Committee (RAC) to block the NIH from authorizing the release of genetically engineered organisms into the environment, author Jeremy Rifkin charged that the rDNA committee "lacks the necessary scientific expertise to evaluate the risk of such experiments." Countering the charge, NIH rDNA committee member Robert Mitchell responded, "our committee is made up of members who know what they're doing and where they're going."

The above comments underscore a growing debate over the ability of existing regulatory structures to cope with the burgeoning commercialization of biotechnology. Since the Supreme Court ruling in 1980 which allowed genetically engineered life forms to be patented, new burdens have been placed on regulatory agencies with jurisdiction over the new industry. Regulatory boundaries have expanded, from overseeing gene splicing in the controlled environment of research laboratories, to reviewing applications for commercial testing of gene-altered organisms.

The benefits of the new technology and its new industry promise to be many. Soon, new life forms capable of 'eating' industrial waste, creating bigger and healthier yields of pest-resistant crops, converting large quantities of biomass into useful products, and a host of other tasks, will be ready for market testing.

The potential risks involved in the deliberate release of organisms with 'nonnatural' genotypes is difficult to determine, because none of these organisms has ever been released into the environment. Uncertainty over the risks posed by "field testing" of such organisms has been a stumbling block for the new industry and a platform for environmentalists pushing for stiffer regulation.

Law suits were recently filed to block the experimental release of a gene-altered bacterium into a field of potatoes. The bacterium, say some experts who favor the field tests, could dramatically lower the risk of frost damage to plants, and the benefits of the frost-preventing microbe could run into the millions for the agriculture industry.

However, the law suits (filed by the Humane Society, The Foundation on Economic Trends, Environmental Action Inc., and Environmental Task Force Inc.) charge that the deliberate release of gene-altered bacterium could have unforeseen impacts on the environment, and that the NIH committee failed to carry out an environmental impact assessment on the experiment. The suits also claim that, because the committee does not include an ecologist trained in the interaction of life forms, it is unqualified to approve field testing of genetically engineered organisms.

Objections over the lack of an ecologist on the NIH rDNA Advisory Committee are but part of a growing debate over what Rep. George Brown (D-CA) characterizes as the "complicated — some would say cumbersome — network of relationships between regulatory statutes and agencies."

"No statute gives any agency express jurisdiction over biotechnology"

In a briefing statement for the June, 1983 hearings on "The Environmental Implications of Genetic Engineering," held jointly by the House subcommittees on Science, Research and Technology, chaired by Rep. Doug Walgren (D-PA) and Investigations and Oversight, chaired by Rep. Albert Gore, Jr. (D-TN), Reps. Gore and Walgren identified grounds for potential legal battles. "The statutes of Federal oversight over the deliberate release of genetically engineered organisms and the environmental questions thereto are uncertain and subject to dispute. No statute gives any agency express jurisdiction over biotechnology."

The NIH's rDNA Advisory Committee has been regulating genetic engineering for several years, though it has traditionally been concerned with issues of biosafety and laboratory conditions, not with deliberate release. In fact, the RAC's jurisdiction over biotechnology is limited to federally funded research — its mandatory guidelines do not apply to the rapidly growing commercial sector, where most research is privately funded. Thus far, the RAC has monitored private industry through a system of voluntary compliance with its guidelines.

To date, the industry has been cooperative. Yet there is growing concern that voluntary guidelines may not be sufficient to monitor a competitive new industry like biotechnology.

A small struggling firm could see advantages in side-stepping voluntary compliance procedures. "Since there are no mandatory guidelines," says an Oversight subcommittee spokesman, "a small firm could foreseeably go ahead with testing its product to beat its competitors to the market. A 'Three Mile Island' potential is very remote. But the magnitude of what could happen justifies concern."

Recently, the Environmental Protection Agency has moved forward to claim jurisdiction over deliberate release cases. The EPA claims authority through the Federal Insecticide, Fungicide and

Since the Supreme Court ruling in 1980 which allowed genetically engineered life forms to be patented, new burdens have been placed on regulatory agencies with jurisdiction over the new industry.

Rodenticide Act (FIFRA), and the Toxic Substances Control Act (TCSA). TCSA gives the EPA authority to regulate 'chemical substances' that pose risks to the environment. However, the EPA's legal claim to authority under TSCA hinges on whether new genetically engineered organisms can be defined as 'chemical substances.'

Another problem area is Congressional intent. The EPA argues that TSCA was intended to be a 'gap filler,' covering areas untouched by other statutes. However, according to Reps. Gore and Walgren, "no indication whatsoever exists that Congress intended TSCA to cover genetically engineered life forms," and to interpret the act as such may "distort" Congress' purpose in enacting the measure. Given the uncertainty over the EPA's authority to regulate under TSCA, court battles could result from any actions taken by the agency in the area of biotechnology.

Currently, no legislation pending on the Hill deals specifically with the deliberate release of genetically engineered organisms into the environment. Despite the controversy over the agency's right to oversee deliberate release cases, it appears that any other legislative or regulatory move will result from a forthcoming public pulicy statement from the EPA.

A crucial task facing the EPA, according to Rep. Brown, is "to define a genetically engineered organism...it will be the first used in commercial regulation and will set the tone for every other agency and Congressional debate on the issue."

House Endorses "Genethics" Commission

To confront what Rep. Albert Gore calls "the tremendous ethical and societal issues that will be generated by human genetic engineering," the House has endorsed the establishment of the President's Commission on the Human Applications of Genetic Engineering. Rep. Gore's bill to establish the Commission (H.R.2788) was added as an amendment to H.R.2350, "The Health Research Extension Act of 1983," which passed in the House on November 17, 1983. H.R.2350, sponsored by Rep. Henry Waxman (D-CA), extends the authorities of the National Institutes of Health and the National Research Institutes.

The Commission would monitor developments in human genetic engineering and advise the President, Congress and appropriate regulatory agencies through written reports.

The overriding purpose of the President's Commission, according to Rep. Gore, would be to develop "A new body of bioethics — 'genethics'...to enable us to come to grips with the technology." The Commission would monitor developments in human genetic engineering and advise the President, Congress and appropriate regulatory agencies through written reports. The Commission would also provide a forum for public education and debate on genetic engineering.

The "genethics" Commission would be an independent, nonregulatory body with members selected from a wide variety of disciplines and appointed by the President. To ensure that the panel focuses on ethical rather than technical concerns, 9 of its 15 members would be nonscientists, including members of the general public. The panel would also include a representative from the biotechnology industry.

The need for an independent body to address the ethical implications rather than the scientific applications of genetic engineering on humans was heightened by a public outcry in June, 1983. A coalition of religious leaders, prominent biologists and social activists, expressing fears over the potential abuses of the new technology, called for a prohibition on human genetic engineering on the moral grounds that it could lead to the alteration of the human species. The President's Commission would serve as a public forum to weigh the potential benefits and abuses of the technology, guiding the Congress, the President and the public in developing a national policy on human genetic engineering.

The Senate version of "The Health Research Extension Act of 1983," S.751, was reported out of the Committee on Labor and Human Resources, chaired by Sen. Orrin Hatch (R-UT), but has not been scheduled for floor action. House and Senate staff members are currently negotiating over whether Rep. Gore's President's Commission bill will be added as an amendment to S.751.

For further information on biotechnology, contact Steve Owens with the House Oversight subcommittee (226-3645) or Annette Taylor with OTA (226-2115). ■

Excerpts from "Genetic Engineering of Plants-
Agricultural Research Opportunities and
Policy Concerns"

Board on Agriculture, National Academy of Sciences 1984

Safety Regulations

The debate about the safety of recombinant DNA research began almost as soon as the first such experiments were reported. In 1971 a molecular biologist proposed to combine DNA from a monkey tumor virus, known as SV40, with a plasmid from the bacteria *Escherichia coli*. This immediately raised fears among some scientists that the modified *E. coli*, containing monkey virus DNA, might somehow infect humans and cause cancer. Though this possibility seemed unlikely, it could not be dismissed for several reasons. First, *E. coli* commonly reside in the human intestine. If the recombinant molecule were inadvertently ingested by a human, it might be able to establish itself in the intestine. And second, though the virus has not been shown to cause cancer in humans, it does cause cancer in mice and hamsters and also causes human cells in culture to grow abnormally. After his colleagues voiced such concerns, the molecular biologist voluntarily deferred his experiment.

When a small group of molecular biologists met at a Gordon Conference in 1973, they again discussed the potential hazards of recombinant DNA experiments. After the meeting, they wrote a letter to *Science* to alert the broader scientific community to their concerns. In the letter they suggested that the National Academy of Sciences investigate the hazard, which it did. In 1974 a National Academy of Sciences committee recommended a worldwide moratorium on certain types of recombinant DNA experiments—such as those that would introduce into bacteria viral genes or genes that confer antibiotic resistance—until the safety hazards could be assessed. They also called for an international conference on the issue and suggested that the National Institutes of Health establish an advisory committee to develop safety guidelines for future recombinant DNA research. All three suggestions were followed.

The conference was held the following year at the Asilomar Center in Pacific Grove, California. By that time the scientists were not only concerned about the deliberate transfer into *E. coli* of a harmful gene, such as a gene from a cancer virus or a toxin, but they also wondered about the unforeseen hazards of combining genes of two different species—even if those genes were thought to be harmless. Since such recombinant organisms did not exist in nature, the scientists could not predict with accuracy what risk they might pose, not only to human health, but also to plants, animals, and the environment.

Nor was the debate confined to the scientific community. The public became increasingly concerned about both the safety questions and the moral and philosophical implications of the new technology. In creating novel organisms, scientists would have the power to alter the course of evolution. Many individuals, including some scientists, questioned whether scientists should be entrusted with such power. They also asked who should decide these issues—the scientists or the public.

Yet at Asilomar, the discussion was focused on scientific issues. The participants agreed that the moratorium should be lifted for the vast majority of recombinant DNA experiments, provided that appropriate precautions were taken. The safety strategy they suggested was that recombinant microorganisms be contained and that the level of containment correspond to the level of estimated risk of each experiment. Containment would be achieved through two methods: *biological*, the use of enfeebled strains of bacteria that could not survive outside of the laboratory; and *physical*, the use of laboratory procedures and equipment to prevent inadvertent release.

A committee of the NIH, now known as the Recombinant DNA Advisory Committee, or RAC, translated those recommendations into guidelines. These guidelines, adopted in 1976, specify the physical and biological containment conditions under which recombinant DNA experiments can be performed.

The guidelines are binding only for federally funded research. To date, industry has voluntarily complied with the guidelines, following procedures suggested in the guidelines for obtaining project approval.

In research conducted since 1979, the alleged hazards have not materialized. As knowledge accumulated, the guidelines have gradually been relaxed—that is, the containment levels required for certain experiments have been lowered. Now most experiments can be performed at the lowest biological and physical containment level.

Nonetheless, some safety questions still remain. One is the risk posed by the intentional release of novel organisms into the environment. Researchers have engineered microorganisms that, in the laboratory, can degrade a dioxin or others that might be used to clean up oil spills. The major uncertainty is whether they will disrupt the balance of the ecosystem in which they are released.

The concern is not with genetic engineering per se. The introduction of any species to an ecosystem it does not normally inhabit can have unexpected results. There are many examples of organisms that have become serious pests after they were released into a new area. In 1869 the gypsy moth (*Porthetria dispar*) was introduced into Massachusetts as part of a silk production experiment. It is now a serious forest pest in much of the Northeast. Prickley pear cactus (*Opuntia*) was introduced into Australia from Latin America and posed a serious threat when it spread into grazing land. The South American cactus moth (*Cactoblastis cactorum*) was deliberately introduced into Australia to bring the cactus under control.

The Need for Continued Diligence

Ray Thornton was an active participant in much of the early debate over recombinant DNA regulation—both as a former U.S. congressman and as chairman of the RAC from 1980 to 1982. He is now president of Arkansas State University. As he described, he addressed another convocation at the National Academy of Sciences seven years ago.

"As I stand here, I can't help but have a sense of déjà vu. This room was filled with people concerned about whether there should be a moratorium on all recombinant DNA research. There were placards, there were protesters, there was heckling from the audience. It took a good bit of courage at that time to stand in this auditorium and suggest that the needs of science called for us to move forward cautiously and carefully in this area. That has changed over the past seven years, and today we recognize the enormous potential benefits that this new technology, this new way of doing things has made possible.

"Perhaps it may also require a bit of courage to suggest to this group today that there is still a continuing need to be aware of the safety, ethical, and moral issues of genetic engineering."

Thornton reminded the audience that these technologies provide an opportunity to direct the course of evolution, particularly to speed it. On a practical level, such changes can disrupt an ecosystem. On a philosophical level, this new ability may undermine man's reverence for life.

Many researchers and observers of the field think that if scientific work proceeds intelligently and prudently, and if scientific directions and developments are open to public scrutiny, then the safety issues can be resolved. Others, Thornton said, are less convinced that humanity is prepared to cope with the moral and ethical aspects of genetic engineering.

To date, scientists have been able to pursue recombinant DNA research with remarkable freedom, Thornton said. The use of voluntary guidelines—rather than legislation—is a novel approach and is far more flexible than the regulations governing the atomic, pharmaceutical, and chemical industries. He sees this freedom given to genetic engineering as a reflection of the public's confidence in the scientific community; of the public's belief that safety issues will be openly and honestly discussed.

"Only a handful of serious safety questions remain for RAC to consider," Thornton said. Among those is the release of genetically engineered organisms into the environment. "We're not talking about working with new organisms in the laboratory. We're talking about what recombinant life forms can be put in an oil well."

Other issues may emerge as the genetic engineering of plants nears application. In deciding what, if any, regulatory approach to take, the RAC or any other oversight body will need to draw on the knowledge of agricultural scientists, ecologists, and others. "One of the things that may have gone wrong six or seven years ago, that may have contributed to the public outcry over recombinant DNA research, is that the molecular biologists who were involved did not have the benefit of input from immunologists, epidemiologists, and others who could have helped them to assess the dangers. Because of this lack of knowledge, the restrictions initially applied were perhaps too severe. We have an opportunity to learn from that mistake. By drawing on the expertise of a number of disciplines, we can develop an approach that both satisfies the concerns for safety, yet does not unduly restrict the application of new research methods."

BIOTECHNOLOGY

Social Benefits

I. Draft Charter Language

The system needs to evaluate the potential positive and negative economic impacts of various types of biotechnology research and commercialization arrangements. Such assessment would help ensure that public biotechnology research benefits the broad farm and public interests.

Issue. What types of biotechnology research and commercialization arrangements are likely to serve the public interest?

II. Additional Background.

The new biotechnologies are likely to have an enormous impact on the agricultural sector over the next two decades. Leading agricultural economists are excited about the possibility of anticipating and planning for these adjustments. However, the public research system has placed greatest priority on establishing a significant biotechnology research program. Broader policy issues may not receive adequate attention. This may lead to public/private sector cooperation and divisions of labor which will not allow society to capture all of the benefits and avoid many of the negative impacts that could potentially result from the new biotechnologies.

The attached five-page briefing paper provides an excellent summary of the possible impact of genetic engineering on the farm and food system. Key issues for this hearing are highlighted. Dr. Allan Schmid, a co-author of the paper, will testify on June 6th. He will elaborate on the role of the Congress and Federal agencies in beneficially influencing the outcome of these adjustment processes.

Additional background material follows the briefing paper.

THE FARM AND FOOD SYSTEM IN TRANSITION
Emerging Policy Issues

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FS15

Genetic Engineering & the Future of the Farm & Food System in the U.S.

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NEARLY EVERYONE agrees that technological advances are essential to the future of agriculture and the consumers of agricultural products. Yet it is uncertain whether our past rate of technical innovation can be sustained, let alone accelerated. On the other hand, large innovations can cause income and adjustment problems in the development of some products. Thus public policies which affect the pace and direction of technical innovations are of urgent concern.

One area in which researchers are seeking to increase the potential for productivity gains is the new biotechnologies, which include genetic engineering. In agriculture, these new biotechnologies possess an as yet undefined potential for increased control and improved techniques in processing and manufacturing new plant and animal products. For example, scientists are expressing great interest in the use of recombinant DNA techniques and protoplast fusion to provide the capability for the transfer of genes between plants, between animals, or even from animal to plant. It may be possible to bring together populations of genes for which natural barriers to sexual reproduction currently exist. It may be possible to engineer plants with such characteristics as nitrogen-fixing abilities, resistance to bacteria or viruses, salt and drought tolerance, and perenniality. Other future possibilities include pesticides and herbicides which can be used to prevent specific diseases or pests, vaccines, plant and animal growth hormones, and fertilizer replacements. Or it may be feasible to use industrial processes (e.g. fermentation) to produce foods which were formerly obtained from field agriculture.

Biotechnology in general, and genetic engineering in particular, currently suffer from exuberant media attention, which has led to much speculation about results of current research. This is due, in part, to the large sums of capital invested in new biotechnology and in part to the confusing use of the terms "biotechnology" and "genetic engineering." Biotechnology is *not* a discipline but a field of activity suitably defined as "the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services" (Bull, Holt and Lilly, 1982). Examples include sweeteners and protein synthesized by bacteria as well as field production of food, fiber, and industrial feed stocks. Genetic engineering is *not* biotechnology, but is the scientific development of techniques for genetic manipulation which will have a substantial impact on biotechnology. Observers are most uncertain about the outcome of this research and development (R&D), in particular about what can be realistically expected in the nature of technological changes and what effect these changes will have on the farm and food system.

This paper illustrates some of the potential changes in agriculture, agribusiness, and the universities. It focuses on the institutional changes and policy issues which cause technological change as well as on those which react to such change.

Some Constraints

It is not the intention here to discuss the technical aspects of the new biotechnologies, which are discussed elsewhere (Bull, Holt and Lilly, 1982, Brill 1981, Barton and Brill 1983, OTA 1981). However, it is appropriate to point out that major technical constraints currently limit the full realization of these new technologies.

For example, scientists do not fully understand how to identify genetic functions and link them to agronomic traits because of the complex dynamic interaction between the genetic materials of various crops (Barton and Brill, 1983). Success with simple microorganisms does not imply equal success with higher plants and animals. According to Brill (1981), what appears to be possible in theory is proving extremely difficult in practice.

Expected Production and Institutional Changes

It is important to recognize that discussion of the impact of genetic engineering on the future of the farm and food system is essentially speculative. It hasn't happened yet! In particular, it should be remembered that statements which reflect negatively on potential changes

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Peter Carlson, Crop Genetics International, and James Nielson, Oregon State University, contributed reviews of the paper. This is one of larger set of resource papers sponsored by the Extension Committee on Policy (ECOP), USDA-Extension, Michigan State University Cooperative Extension Service, and the various universities and organizations that supported those who have contributed papers and reviews.

do not necessarily imply that the technology itself should be viewed negatively. Rather, these statements represent possibilities which should be taken into account when changes in institutional structure are considered.

Changes in Agriculture

Because the U.S. food system is so complex and diverse, it is extremely difficult to measure the magnitude or direction of the effects of breakthroughs in biotechnology. Current expectations of new types of plant life which can, for example, biologically fix nitrogen, may have a tremendous effect on the demand for nitrogenous fertilizers, natural or man-made. Plant life which is genetically adapted to resist bacteria or viruses, to tolerate salt, drought, or cold, or to retain immunity to pesticides may affect the costs of inputs and location of production. Plant life which is genetically engineered to be perennial, or plants with increased photosynthetic efficiency or increased hybrid-vigor may affect the magnitude of production. The possibilities of producing energy-crops at levels which make them cost-effective may further reduce input costs.

Biotechnology is already making large inroads into animal research. One example of a newly developed biotechnology is bovine growth hormone (bGH). Depending on the stage of lactation, 44 mgs. of bGH injected into a dairy cow daily can be expected to result in a 15 to 40 percent increase in milk production, regardless of the cow's normal production level (Kalter, 1983). Another example is the development of embryo-transfer. It is now possible, and is becoming widely acceptable, to transplant live embryos of championship, high quality dairy and beef cattle to recipient cows in order to gestate and produce genetically superior cattle. Through cryobiology, these embryos may be stored and transported for use at any time and any place in much the same way that semen has been stored and transplanted for years (Brotman, 1983).

Technological change has been the dominating factor in changing the structure of agriculture. According to recent projections to the year 2000 by Lin, Coffman, and Penn (1980), the proportion of large and small farms will increase and the proportion of medium-sized farms will decrease. Land ownership will be dominated by fewer farms, and by the year 2000 the largest 1 percent of farms will account for about 50 percent of total farm production. About 50 percent of the farm land will be farmed by the largest 50,000 farms and about 2/3 of the wealth in the agricultural sector will be in the hands of the top 20 percent of farmers. If anything, breakthroughs in biotechnology will simply accelerate this trend. For example, it is estimated that the development of bGH alone suggests that our national dairy herd may need to be reduced to 60 to 70 percent of its current size by the year 2000 if bGH is widely adopted (Kalter, 1983).

Overproduction is another problem which has plagued U.S. agriculture. Increasing agricultural productivity so that resources can be used more efficiently elsewhere is a desirable goal but it creates a problem if it continues to be a source of instability in agriculture. According to many authorities, there is no known physical or technical reason why basic food needs cannot be supplied for *all* the world's people in current technology. These needs are not now being met because of social and political structures and values *not* because of physical scarcity (OTA, 1982).

Changes in Agribusiness

Agribusiness comprises the support industries which service agriculture. It includes all of the marketing and distribution functions which take place beyond the farm gate, including those industries which supply agricultural inputs.

On the input side, the development of a new genetic engineering industry is underway. The proprietary possibilities of biotechnological research have encouraged the development of about 200 new firms. Many of these are small enterprises funded by venture capital. Others are owned or were established by large multi-national petro-chemical and pharmaceutical interests who have also been buying seed companies. Speculation about the potential for genetic engineering has contributed to many mergers and takeovers of seed companies. Changes which occur in the engineering of new plants will be expressed and distributed in the seeds of such plants. Thus any firm or corporation which intends to invest in the new biotechnologies may be at a distinct advantage if it can market its products through an established seed company. There are also other reasons for such mergers. For example, there are obvious compatibilities between resource uses in genetic engineering in general and in the seed industry. There is also the possiblity of making unique combinations of plants and accompanying pesticides and herbicides. An integrated firm may develop varieties that are productive only if its brand of pesticide or herbicide is used as well. Other input industries which may be substantially affected by breakthroughs in the new biotechnologies include the manufacturers of fertilizers, pesticides, farm machinery, and feed stocks. In addition, it can be expected that the biotech firms themselves will create the need for support industries to provide them with supplies of various sorts.

On the output side, changes will occur as new agricultural and food products are developed. Artificial sweeteners are a current example. Processing and manufacturing energy-producing substances may substitute for processing oil and coal. An assessment of the ecological consequences must precede the large scale development of these industries so that we can avoid previous mistakes of ecologically damaging dependencies on oil, coal, and chemical substances.

Changes at Universities

The private sector's demand for highly trained genetic engineers has created a shortage of personnel at universities. This shortage could threaten the long term viability of biotechnological research. At a time when more personnel need to be trained, universities lack the faculty members to do such training.

The seed industry is pressuring the universities to reduce their role in the release of finished varieties and to restrict themselves to basic research. Some universities for example have reduced or eliminated their corn breeding programs. If universities are not involved in the whole process, how can they maintain their expertise in teaching? The USDA is reducing its breeding research and its role in coordinating the state experiment stations.

Generally speaking, industry has supported increased cooperation between private and public sectors but the potential for conflicts has prevented total integration of public and private biotechnological R&D. For example, conflicts may occur if private industry demands increased influence over public research agendas and increased control over the dissemination of research results which have proprietary potential. Conflicts may also be aggravated as certain land grant universities rely more on private funding and royalties and less on public funding, and as the competition for prestige between universities increases.

Changes at the Federal (Legislative) Level

Changes in legislation affect institutional structure. The recent announcement that the EPA has decided to take over the regulation of the genetic engineering industry is likely to influence considerably the type of legislative changes on the horizon. While many of the products of biotechnology will not require special regulation, the EPA's primary task will be to ensure environmental safety. It will therefore influence the regulations which are an important part of the biotechnical research industry's institutional structure. The industry is split in its opinion of EPA involvement. Some researchers believe that the sooner regulatory guidelines are set down, the sooner they will be able to go ahead with manufacturing new products. Others believe that there is little need for regulation because many of the products will be common pharmaceutical and agricultural chemicals.

Similarly, health and safety standards of rDNA research are also strict but mostly voluntary. As private research firms increase their participation in rDNA R&D, they are likely to bring pressure to bear for relaxing these standards. The current arrangements for transferring licenses on patented/protected material from universities to commercial enterprise are in a state of flux. Some private firms object to being excluded, but others argue that they can't afford to develop and market a new product without exclusive rights.

Finally, the passage of the Plant Variety Protection Act (1970) and the 1980 Supreme Court decision (in re *Diamond* v. *Chakrabarty*) to allow patenting of life forms under Section 101 of the Patent Act have nominally increased the protection available to the seed industry and the genetic supply industry. However, members of both industries are expressing considerable discontent with the current laws, fearing they may not provide a level of protection commensurate with investment in R&D. Thus there may be increasing pressures on government to tighten or change some aspects of the patent/protection laws.

Policy Issues for the F&F System

Public vs. Private Research

It is becoming increasingly popular for universities to sponsor conferences which explore university-industry relations. The most widely publicized of these was the Pajaro Dunes, California, meeting in May, 1982, which was attended by the heads of 5 major research universities and 11 corporations involved in biotechnological research (Culliton, 1982). Participants in these conferences express concern about potential conflicts between private sector objectives and public research agendas. This concern is summed up in a sentence from a statement released at the Pajaro Dunes conference:

> . . . research agreements and other arrangements with industry [must] be so constructed as not to promote secrecy that will harm the progress of science, impair the educational experience of students and post-doctoral fellows, diminish the role of the university as a credible and important source, interfere with the choice by faculty members of the scientific questions they pursue, or divert the energies of faculty members and the resources of the university from primary obligations to teaching or research.

The issues are both complex and contentious. According to Hess (1982), the real problem with biotechnology is that capital is invested in ideas rather than in a physical product. If proprietary rights are established, then the discussion of the idea amongst interested faculty ceases since it becomes a secret. This barrier is exacerbated if faculty members have equity or financial interest in the capital invested in the idea. As a result individual faculty members often alienate themselves, neglect their duties and their graduate students, and may decide to leave the university for the larger financial gains available in the private sector.

Many universities have a policy of accepting private grants only if they fit into ongoing research for which a place on the agenda has been established by other criteria. However, the problem is likely to be exacerbated because of the increased involvement of a wider spectrum of university departments in biotechnology, and because of private industry's aggressive search for solutions to technical constraints and potentially large financial rewards.

Private firms are also concerned about these issues because they rely on much of the basic research carried out at universities. Many firms cannot afford to invest the capital resources needed to do this basic research themselves. Another problem also arises as federal support for graduate training and research declines. Universities have often viewed the private sector as a possible source of additional financing. However, if universities establish policies that aggressively exclude private sector involvement in research, then the private sector will have little incentive to fill the funding gap which is developing.

Apart from the concerns of the university and industry, a third perspective—the public concern—is also relevant. There is much debate about who owns publicly funded research and about whether or not everyone has free access to all of the ideas (Bouton, 1983). When private grants are made, the researchers involved often use publicly financed equipment and build their research on publicly financed knowledge, which makes claim on any final point product hard to determine.

Patent Issues

Currently there are two legal mechanisms for protecting an invention. One way is to make use of the protective institutions of the Plant Variety Protection Act (PVPA of 1970) for sexually propagated plants, the Plant Patent Act (1930) for asexually reproduced plants, and/or the Patent Act for any life form. The second way is to rely on that body of common law which governs trade secrets.

As already mentioned, members of the genetic supply industry have expressed some discontent about the ineffectiveness of the current protective laws. A major problem is the fact that an application for a patent on a process requires information about this process. If such information becomes public, as is usually required, it provides enough information to competitors to make the patent ineffective, i.e., competitors can create a near substitute. The general intent of the patent laws, and of the additional protective legislation for plants, is to induce inventors to make their ideas available to the public so that these ideas can be further improved for societal benefit. In return the inventor is granted exclusive ownership and control of the present invention. Trade secrets, on the other hand, (derived from common law and not specifically created by statute) are protected as a right by the courts, but do not require public disclosure of information. However, an individual or a company relying on trade secrecy to protect an invention is responsible for the security of the secret. Thus the trade-off between trade secrets and patents becomes one of deciding what is to be protected and at what cost.

The discontent with these alternatives becomes obvious. Researchers in genetic engineering firms who want to protect their findings want both legal protection *and* nondisclosure. Under current legislation, however, it is not possible to acquire both of these forms of protection.

There is, however, a third alternative. It is possible, particularly in plant breeding, to breed as an end product a hybrid or hybrid-like product which will not breed true to form in the ensuing generations. These unique products have their own natural protection system since the inbred parents are relatively easily kept as proprietary material (even secret, at a relatively low cost), and because it is not possible to reproduce the special qualities of the F1 hybrid without access to the inbred parents.

The hybrid prevents the farmers from growing their own seed (Schmid, 1984 and Berlan, 1981, 1982). If institutions can't provide exclusivity and return to research, breeders may adopt hybridization even if it is not otherwise the best approach to varietal improvement. Thus institutions may unwittingly shape the research agenda.

Another current potential problem in the pesticide industry, one which could affect the biotechnology industry, is the length of time it takes to get EPA approval. At present, it takes about 7 years to get approval from EPA for pesticides. Since the life of a patent is 17 years, this leaves a firm only 10 years to recoup its investments, which may be insufficient. If health and environmental regulations are applied to the biotechnology industry, this difficulty is likely to create discontent and pressure for change.

The issues here require clearer definitions of property rights. Is it possible, for example, to design a protective mechanism which will provide firms opportunities to recover their investments, while at the same time ensuring that patent claims cannot be misconstrued and that the legal monopoly granted will not result in a complete deterioration of market forces?

Industrial Market Concentration

The takeovers and mergers in the seed industry over the last decade, together with the increase in the relative prices of seed and the establishment of patent-like protective institutions such as PVPA and extension of the Patent Act, have triggered considerable concern about the possibility of substantial market concentration occurring in the industry (Butler and Marion, 1983). Evidence collected to date suggests that the seed industry is currently in a state of transition. Private enterprise is taking over some of the functions which have traditionally been regarded as belonging to public research institutions. While structural and behavioral changes are occurring, it may be too early to judge yet whether these changes will result in the emergence of highly concentrated subsectors.

Several factors will determine whether or not changes in the seed industry, or more specifically, the genetic supply industry, will result in increased concentration of sales among the largest sellers. Much depends, for example, on whether or not the envisioned breakthroughs in the new biotechnologies actually occur and whether or not they will be commercially feasible. Much also depends on how much and what forms of protection and barriers to entry the industry can achieve to protect its commercial investments in the new biotechnologies.

In many ways, the envisioned breakthroughs in the new biotechnologies strongly resemble the discovery and commercial development of hybrid corn in the 1930's. Today, the corn seed subsector is the most highly concentrated of all the seed subsectors. Typically, the corn seed subsector prevents farmers from growing their own seed, exhibits relatively high barriers to entry, and is dominated by a few large companies. It is possible that commercially successful breakthroughs in biotechnological research will result in other subsectors of the seed industry becoming equally as concentrated as the corn seed subsector. Whether or not such breakthrough will significantly affect market forces is unknown.

Genetic Diversity and Other Nonprofitable Improvements

Genetic diversity is one of the basic underlying precepts of plant and animal breeding. It is the range of genetic differences between individuals or groups of organisms. Genetic diversity reflects the ability of an organism to utilize the full range of its genetic resources to survive in various environments. For example, an organism with a narrow spectrum of genetic resources will survive only in a narrow range of environments and may be susceptible to a single virus or strain of bacteria. Thus genetic diversity is essential to the maintenance of our food system (Dept. of State, 1982).

Uncertainty arises over the question of the potential effect which bioengineering may have on this diversity. The new technology of embryo transplants for dairy cows seems to have the potential of considerably narrowing the variety of females following the narrowing of bulls achieved by artificial insemination.

While most breeders and scientists recognize the value of genetic diversity and its necessity in maintaining plant and animal systems against the onslaught of unexpected viral or bacterial attack, most private breeders cannot afford to breed for genetic diversity or other hard to perceive quality improvements because there is no commercial market for them. Since the goals of breeding are determined primarily by the commercial feasibility of marketing, there is a tendency to breed organisms with characteristics which are "saleable." This tendency tends to narrow the spectrum of genes available, thus inadvertently leading to the creating of genetically vulnerable plants and animals.

There are other quality changes which may be incomprehensible and thus give commercial breeders no opportunity for profit. For example, a public breeder may have the incentive to make small improvements in the protein content of cereals, improvements which would be a waste of time for a private breeder.

Conclusions

Genetic engineering and biotechnology hold the promise of significantly altering the speed and content of technological change. They could produce dramatic changes in farm production and agri-business and in the functions of research and education. Technology will affect the performance of present institutions. And institutions affect the manner in which the potential benefits and costs of technology are realized and distributed. This paper addresses some of the policy issues that will have to be dealt with in the future.

One set of issues involves the mix of private and public research. Cumulative public decisions now seem to place greater reliance on private research and private finance even when the research is done in public universities and mixed with public funds. How will the institutional incentives affect the supply of basic research, the training of future scientists, the choice of subject matter, and the communication of knowledge?

Property rights (patents) in inventions are important if the role of private research is to expand. Can a balance be found between rights of firms to recover research investments and the interests of the consumer in avoiding unreasonable monopoly profits? How do other market strategies leading to oligopoly interact with rights in inventions? How do requirements for patents affect the research agenda? What are the incentives to achieve genetic diversity and other hard to perceive improvements in quality? Will farmers be eliminated as producers of their own seeds and will this create large profits in the seed industry?

Agricultural policy makers have tried to achieve a delicate balance between the need for continued improvements in agricultural productivity and the problems of adjusting to overproduction. This task will not be made any easier if genetic engineering significantly affects technology. Changes in plant tolerance for environmental conditions and disease could greatly alter regional production patterns. Growth hormones and disease control could alter the supplies of milk and other animal products. Large shifts in demand for certain agricultural inputs and the demand for land could occur. All of these things could affect the incomes and asset values of farmers and agribusiness people to a greater magnitude than any past technical change. In short, important policy decisions must be made. These decisions will affect the pace and the content of agricultural productivity and the distribution of its costs and benefits.

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Social Science Implications of Agricultural Science and Technology: Discussion

Michael J. Phillips (Office of Technology Assessment)

Excerpts Amer. J. Agr. Econ. December 1983

. . . With university research funding remaining almost static over the past fifteen years, private sources of funding particularly for biotechnology research have increased substantially. Major areas of conflict and debate have emerged in recent controversy over university-corporate relationships regarding biotechnology. These include (*a*) conflicts of interest, (*b*) nature of public equity in university research, (*c*) control and dissemination of research results, and (*d*) structure of new organizational forms and contracts linking universities and corporations (Buttel et al., p. 30).

Land grant institutions are not immune from these concerns. Even though they have not been leaders in biotechnology research, there are some, such as the University of Wisconsin-Madison and University of California-Davis, that have critical mass and private supported research programs in biotechnology. The unique feature of biotechnology research is the identity of immediate beneficiaries of this research; they clearly are private firms—many of them among the largest multinationals—and thus involve a significant symbolic switch of clientele of land grant schools from farmers and rural people to agribusiness including multinationals. Without research on the externalities, equity, and distributional impacts of biotechnology research, it is at best embarrassing for biotechnology researchers and administrators of land grant universities to convince a public that the public interest can be served by enhancing the product lines and profitability of a handful of very large firms.

The technologies of the future demand a new research agenda by social scientists. As Bonnen and Evenson have concluded, and I fully concur, new priorities for social science research include (*a*) studies analyzing prior research progress and the distributional consequences of these research programs, (*b*) assessment and design of new technologies so as to anticipate and avoid undesirable externalities, and (*c*) development of new institutions or adaptation of old institutions to change to ensure or at least facilitate desirable public outcomes.

However, the present organizational structure of our agriculture research institutions is not conducive to such a research agenda. Such an agenda requires the integration of biological and physical science with social science research. The greatest challenge for a research administrator today is determining the organizational structure and appropriate incentives conducive to interdepartmental and interdisciplinary research (Phillips and Dalrymple, p. 993).

The new research agenda is not devoid of reality. I am confronted almost daily in my interaction with congressional staff with questions that only the new research agenda can adequately answer. An OTA study that has been recently requested by Congress will focus on the impacts of new technological developments in agriculture, public policy, and impact on the changing structure of American agriculture. Such concern by policy makers underscores Bonnen's statement that we seem to be at a node in the evolution of modern industrial agriculture with fundamental choices to be made about its future path. There is, however, little in the literature or in present research activity that is helpful to us in providing substantive information to policy makers on the choices to be made. To complicate matters, many of these choices will be made by policy makers that have little or no knowledge of agriculture and in some cases even less empathy with farmers, science, or business in agriculture. I agree with Bonnen that the scientific professions—especially the social sciences—have a major responsibility to provide relevant and objective knowledge and analysis for those public decisions. For our discipline to be relevant not only for tomorrow but also for today, it is time to get on with the new agenda.

Social Science Implications of Agricultural Science and Technology: Discussion

Clark Edwards

(Economic Research Service)

Excerpts Amer.J.Ag.Econ. December 1983

Let me expand on Evenson's review of some of the things likely to happen when molecular biology results in a substantial increase in corn yields. According to an ERS mathematical programming model, corn production will increase and the price received by farmers will decrease. More and cheaper corn will be used in feed, food, industrial, and export markets. Less land, labor, and other resources will be used in crop production, leading to capital losses and reduced incomes to suppliers of these resources. Lower feed costs will induce more livestock production leading to the use of more labor, pastureland, and other livestock inputs, and to reduced prices received for livestock products. Net farm income will decrease, as will the incomes of the suppliers of most farm inputs. Consumers will gain because they will be able to buy more food products at lower prices and for a smaller share of disposable personal income. The domestic marketing sector will grow and profit from the increased volume of handling and processing. And trading partners of the United States will be able to acquire more of our exports at lower prices.

In addition, some important regional shifts can be expected. Incomes likely will rise for farmers in the Southeast and Delta states who have access to additional land suitable for corn. And incomes likely will rise for farmers in the Pacific and Great Lakes states who exploit their comparative advantage for feeding cheaper grain to livestock. Income losses might be greatest for farmers in the Northeast and Southern Plains states. The Northeast region likely will produce more milk at a lower price with little change in revenue while producing less poultry and other livestock and less crop products. The Southern Plains region likely will produce more cotton and beef but plant fewer acres of grain.

Evenson suggests that postharvest technology affecting processing and distribution of farm products increases farmers' profits. This might be so if the technique reduced the cost of delivering a dozen eggs to the consumer from the farm gate. But it would not be so if the technique resulted in fewer cracked eggs and reduced the number of eggs required at the farm gate to deliver a dozen to consumers.

Technological advance is a public good. Prospects for a generally lower level of farm income and for disparate regional consequences—what Bonnen calls spillover effects—raise a serious question as to whether either private firms or the state experiment stations can, without conflict of interest, develop new technology in the absence of a guiding and supporting national policy. Nationwide institutions are needed to do some of the basic research, guide development and adoption, and promote justice in the distribution of the tremendously large private and public social benefits to be derived therefrom. Otherwise, we fall back on the old rule that the rich get richer.

Note: Model assumes an increase in production without a corresponding increase in demand.

NEEDS ASSESSMENT

Setting Priorities

I. Draft Charter Language

Section 1407(d)(2)(G) of Title XIV requires the Joint Council to develop annual Priorities and Accomplishment reports. The Joint Council's FY 1986 Priorities report, to be released in June, will be the first one to use Needs Assessment findings. The FY 1985 Priorities report was significant because it selected and ranked a limited number of priority areas. Biotechnology, the highest priority, received a major emphasis in the budget. However, five of the seven other highest priority areas received no special emphasis. It is unclear the extent to which the system is redirecting resources into the priority areas.

Since the broad priority areas should not change radically from year to year, there will be an opportunity in future reports to provide an additional level of detail by highlighting and justifying the critically needed research, extension and teaching efforts within each broad priority area. Witnesses at the research hearing last June stressed the need for economic analysis and critical path analysis in setting research priorities. This could help establish that the problem is economically significant, deserves early attention and that the technology selected to address the problem is expected to have socially desirable spin offs. The Needs Assessment hints at urgent research priorities (e.g. plant growth in unfavorable environments). These need to be made more explicit.

The annual Accomplishments report might be made more useful by relating it to previously identified priorities, showing the system's success at directing resources to these areas and recounting accomplishment in these areas.

Issues. What can be done to encourage greater use of economic and critical path analyses in setting priorities? Do the Joint Council and Users Advisory Board have a role in setting more detailed priorities and making more explicit the selection rationale?

II. Additional Background

The Needs Assessment is a voluminous study of the most urgent needs and most promising opportunities in every program area. Almost every major concern about the food and agricultural system is covered in some manner in the study. The report is being used to inform policy officials of the serious needs facing agriculture. It is less clear what impact it will have on setting priorities throughout the system.

The Needs Assessment was not intended to set priorities. Based on Needs Assessment findings, broad goals and objectives are set in the Five-Year Plan and a few are selected for special emphasis in the annual Priorities Report. The Five-Year Plan (now being printed) ranks goals in each major area. For example, under Crop Production and Protection the first goal is "Reduce crop production costs and related losses." The only other goal listed is "Develop technologies appropriate to specific types of production systems (large monocultural grain systems, family farms, and small high-value specialty systems)." Each goal has several objectives under it (ref. attachment).

These goals are very broad and non-quantifiable. The objectives under each goal are intended to state more specifically the planned results. But it will be difficult to measure progress toward the objectives in the Five-Year Plan. For example, there is only one aggregate base given for the entire Crop Production and Protection area, even though it includes two goals and nine objectives. The aggregate base shows 4000 research scientist years in 1983 and 4003 in 1988 with no real growth in overall system funding. Extension projects a reduction of 80 staff years (2%) in this program area through 1988 at the no real growth level.

Research effort in the top four major program areas (crops, animals, post-harvest and forest/range) is projected not to change through 1988 with no real growth in overall funding. This does not necessarily mean that changes will be minimal. There may be more substantial redirections in subcategories. This is difficult to establish since research managers project changes using different categories than those used as the Joint Council goals, objectives and priorities. Also, the research projection cycle began more than a year and a half ago, long before the Needs Assessment and Five-Year Plan were completed. The Extension projections are more current. Extension shows more substantial redirections at the no real growth level. Research and Extension projections are shown in an attachment.

The goals and objectives in the Five-Year Plan are quite extensive. The 44 goals and 156 objectives are not ranked across major program areas. They could serve as a menu from which the Joint Council may select a few high priorities. The 1984 Priorities Report, however, mostly kept priorities at the major program level (e.g. Forest, Range and Pastureland Productivity). Five of the eight priorities were at the major program level. Three were at the major goal level. None were at the more measurable objective level.

Setting more detailed priorities might improve system response and Federal budget requests. Many of the current general priorities have not had a major impact on the budget, as shown by the following table.

Joint Council FY 1985 Priorities (Ranked)	FY 1985 Budget Action
1. Basic Biotechnology Research	Major increase in competitive grants, some increase in Hatch and ARS.
2. Scientific Expertise Development	Termination of fellowship grants.
3. Communications Technology	No increase in Extension. Small increase in NAL.
4. Analysis of Price and Income Policies with Emphasis on Foreign Trade	Increase in ERS.
5. Sustaining Soil Productivity (controlling soil erosion)	Small increases in ARS and Extension. Termination of STEEP grant.
6. Human Nutrition, including Food Safety and Quality	No increase in ARS or CSRS. Major cut in EFNEP. Small increase in HNIS.
7. Water Management	No increase.
8. Forest, Range and Pastureland Productivity, including Multiple Use	Significant cut in Forest Service research. Slight reduction in Cooperative Forestry Research.

This limited impact on the budget could be attributed to extraneous factors, such as the Federal deficit and the need to reduce USDA discretionary spending. However, more detailed priorities might make the budget request easier to sell.

It would be difficult for a group as diverse as the Joint Council to agree on more refined priorities. Congress might encourage the Joint Council to undertake a systematic assessment of one goal, such as reducing crop production costs. The assessment should evaluate the potential economic pay offs and social/environmental benefits of breakthroughs in each of the eight objectives under this goal. For example, objective three ("Understand and improve the performance of plants in unfavorable physicochemical environments") might have a very high priority. This is hinted at in the Needs Assessment since average yields are only 21% of record yields. Most of the gap is due to unfavorable environments. Only one-seventh of the gap is explained by disease, insect and weed losses.

The recently completed report required by Title XIV on soybean research and extension needs is another opportunity for further analysis. Since the supply/demand study in the Needs

Assessment projects oilseeds to be a major growth area, setting priorities in this one commodity area could have a major impact. The recent soybean report selected priorities in each major research area based on expert judgment. Priorities were not established across major research lines. Congress could use this commodity as a test case to see if any research planning methodologies could be used to select a few soybean research and extension areas for special national attention. Ruttan has described the available research planning methodologies and noted the drawbacks of each. Agricultural Economists are not yet totally reliable in predicting the future. But they should be able to offer some analysis of the relative economic significance of a problem, and to evaluate the likely social/environmental impacts of particular research directions.

In summary, the Joint Council planning process required by the 1981 Farm Bill is operational but difficult to evaluate. It is serving to increase awareness of the diverse needs and opportunities. But, due to the complexity of the system, it lacks the clear statement of priorities that can be found in the ARS plan. As pointed out in the recent study "The Paradox of Success: The Impact on Priority Setting in Agricultural Research and Extension," by Jean Lipman-Blumen and Susan Schram, long range planning has become a shibboleth for the system. The password has been learned adequately to maintain credibility. The process may need refinement if the hope is to develop a new national consensus on priorities that will lead to increased real funding.

Additional background material is provided on the following pages.

NEEDS ASSESSMENT REFERENCE DOCUMENT

Joint Council
January 1984
p. 146

TABLE 1: Record Yields, Average Yields, and Yield Losses Due to Diseases, Insects, Weeds, and Unfavorable Physicochemical Environments in Major Crops of the United States as of 1975 (data are from Footnote 3, page 1).

CROP	RECORD YIELD	AVERAGE YIELD	AVERAGE DISEASE LOSSES	AVERAGE INSECT LOSSES	AVERAGE WEED LOSSES	AVERAGE LOSSES DUE TO UNFAVORABLE ENVIRONMENTS
			Kg/Ha			
Corn	19,000	4,600	836	836	697	12,300
Wheat	14,500	1,880	387	166	332	11,700
Soybean	7,390	1,610	342	73	415	4,950
Sorghum	20,100	2,830	369	369	533	16,000
Oat	10,600	1,720	623	119	504	7,630
Barley	11,400	2,050	416	149	356	8,430
Potato	94,100	28,200	8,370	6,170	1,322	50,000
Sugar Beet	121,000	42,600	10,650	7,990	5,330	54,400
Average Percentage of Record Yield	100	21.5	5.1	3.0	3.5	66.9

Historical Sources of U.S. Agricultural Productivity: Implications for R&D Policy and Social Science Research

Amer. J. Agr. Econ.
December 1981

James T. Bonnen

Excerpts

Implications for Social Science

What are the implications for social scientists in agriculture? The changes in the research agenda involve a return to two of our profession's earliest contributions. We face fundamental changes in the technology and institutional structure of agriculture. Thus, we must return to the development of quantitative data bases and analysis to describe the new structures and behavior and to measure performance and define problems. Second, we must return to work on institutional innovation to solve problems. Neither is currently viewed as important by the main line of the profession nor by experiment station and college leadership.

Distributional or equity issues are becoming as important as productivity. The externalities to public policy and research are one cause. As the scope of private sector activities grows under the impact of new technologies and institutions in agriculture, other externalities are created and property rights are redistributed and redefined. New questions need to be addressed ranging from that of public property rights in information generated in increasingly concentrated agribusiness sectors to the performance and equity of outcomes in markets and communities where new technologies and institutions are being used by marketing firms to control farm product flows and prices. These firms are reducing their costs by generally abandoning the unprofitable processing functions to farmer-owned co-ops and forcing onto the farmer most of the previously shared price and income risks arising from production uncertainties (Hamm).

• • • Changes in society's values and social agenda, in part the consequence of externalities to agricultural policy and production, will remain an important source of disequilibria. This will require not only social science, physical and biological science, but also humanities research on the ethical and value conflicts in the choices that must be made (Johnson).

The demand for social science research is increasing and shifting toward such matters as statistical development, technology and institutional assessment, research program evaluation, and to needed institutional innovations and the adaptation of old institutions to change. The evolution of modern industrial agriculture is at a node. Fundamental choices must be made about its future path.

Many of those decisions will be made in a politically fragmented public decision environment by individuals and organizations that have little or no knowledge of agriculture and even less empathy with farmers, science, or business in agriculture. The science professions have a major responsibility to provide relevant and objective knowledge and analysis for those public decisions.

If society views agricultural technology as a "cannon loose on the deck," the only intelligent response for agricultural leaders is to manage the development of technologies to anticipate and avoid major undesirable externalities. The next cycle of agricultural change must combine social science with biological and physical science research to assess, guide, and legitimize the development and adoption of new technologies. Agricultural research institutions cannot behave in an irresponsible manner and still expect to be funded by society.

Agricultural economists, with other agricultural scientists, must put assessment of technology, institutions, and human capital needs high on their agenda. We must analyze the impacts of the computer and communication technology revolution, the institutional and technical alternatives, and their effects on agriculture and its institutions. We must address the potential impacts of molecular biology, not only on the organization and performance of agricultural production and marketing institutions, but on the public.

These two sets of technologies have profound implications for the organization of research and its communication to use. They will change the answer to the question of what is best done in the private or in the public sector. We must modify the public research and extension role to take advantage of the opportunities and manage the challenges that flow from these technologies.

ECONOMIC ANALYSIS

Summary: Needs Assessment for the Food and Agricultural Sciences

Joint Council January 1984 (excerpts)

3

The technology development process must continue to consider *the incentives of final users.* Before new or existing techniques are adopted by an owner, manager, or consumer, many questions need answers. Will an alternative approach be more cost-effective? Can the farmer afford the additional cost when the prices of wheat, corn, or stumpage are so variable? What financial plan best fits a given farmer or household? The unique aspect of agriculture is the *extension educational process.* State specialists and county agents who interact regularly with the researchers also have the trust and understanding of producers and consumers. They take available research data from multiple sources and develop educational packages that consider the needs of users.

23

Science programs of the future will include two common features—systems analysis and economic feasibility studies. Scientists will integrate data from basic and applied research into models that simulate agricultural activities and practices. Then, by the process of systems analysis, they will compare the effectiveness of alternate strategies before testing and validating the results in a field experiment. Economic feasibility studies should increase effectiveness of research investigations and extension programs and provide needed information for potential users of new or existing technologies. The development of microcomputers and associated telecommunication systems enhances the use of these techniques. These two features apply to most of the following categories.

Economic Analysis in Research Planning

Dr. John Lee (ERS)

Research Hearing June 22, 1983 (excerpts)

24

With respect to how we get involved in broader agricultural research planning, economic information is an important ingredient in planning mission-oriented biological and physical science research. Our projections of future global demand for and supply of food and agricultural production resources provide information for decisionmaking on the magnitude and allocation of public funding for agricultural research. Economic information can help identify research investments with the greatest potential return to agriculture.

Economic analysis on the potential demand for the various commodities and production costs, resource constraints, and other factors can help pinpoint areas where research can be most beneficial to farmers, consumers, and the whole country.

Economic research can also contribute to improved understanding of a variety of direct and indirect consequences of technological change.

Technological change is often not neutral with respect to its impact on scale of production or the distribution of returns. Likewise, the feasibility or ease of adoption of new technology is influenced by economic and institutional factors which may vary considerably among types of farms, by regions, et cetera.

Hence, when making decisions on the development, application, and extension of new technology, we need to know the likely effects on production and marketing institutions, farm income, costs and returns, management of public policies and programs, and the competitive position of the United States in world markets. This information can facilitate the development and application of technology in its most effective form, and can facilitate adjustments to eliminate or alleviate undesirable or unintended side effects.

We pledge in the ERS to continue to work with our colleagues in Federal and State research agencies and in the private sector so that their planning decisions benefit from the best economic information we can make available to them, and to insure that together we can make the most effective use of our limited resources in meeting the needs of America's food and fiber industry.

Mr. EVANS of Iowa. Well, no. My question is in the process of trying to decide where the priorities should be within the Department and where the money should be placed, is the subject of economic returns from those various areas of research or applied research—is that question ever brought to you and your group for an analysis?

Mr. LEE. Yes, sir. It is.

An example of the way that kind of a question gets brought to bear is in the process now underway—the long-term assessment of needs which starts with trying to identify what are going to be the economic and supply-and-demand food situation for example globally out in the long term, and what is that going to imply about the need for science to deal with some of the bottlenecks or some of the problems that are going to arise, so we get involved in that process on a cooperative basis with the Agricultural Research Service for example and with the whole science and education establishment.

We also get involved in looking at some of the economic impacts of various kinds of technological developments and potential breakthroughs.

Since Dr. Bentley has arrived we have had similar discussion and we hope to build on that with Dr. Bentley and Dr. Kinney of how we can work more directly with the Agricultural Research Service to help provide some of this cost-and-benefit analysis.

We don't at this point have a formal program of preassessing all potential areas of research for looking at what might be the highest rates of return. It's not a formal program.

Mr. EVANS of Iowa. They never come to you when they are trying to decide whether to continue say the "fire-ant program" and say:

> What are the economics of solving this program, and here are the costs involved, and the research in the judgment of the economic research people, does this make good sense as a place to put Federal dollars?

Is it ever approached from that point of view?

Mr. LEE. It is not approached from a systematic point of view of every project like that coming to ERS, but they do those kinds of assessments within ARS with their own staff, and at varying times depending on the nature of the subject and whether we have any expertise in that area we are called upon to assist at times.

Five-Year Plan for the Food and
Agricultural Sciences

Joint Council on the Food and
Agricultural Sciences May 1984

(EXCERPTS)

Crop Production and Protection

During the last 40 years, crop productivity has increased dramatically in the United States. The increase resulted from inherent changes in the productivity of crops, advances in crop protection, and improved cultural practices. In general, about half of the gain in productivity is attributed to improved plant potential and half to improved management practices. Past rates of advance will be difficult to continue without using new approaches. This phenomenon, sometimes referred to as a yield plateau, may be caused by physical, biological, and economical factors. The high cost of farm production relative to income may be the most urgent problem facing U.S. agriculture. Science and education programs will need to stress technologies that will maintain or improve production while holding constant or reducing the input of scarce and expensive resources.

Rising Costs of Crop Production:
During the period of 1966 to 1979, total farm expenses increased by 320 percent, but cash receipts for farm products increased only 280 percent. Most of the increased expenses were attributable to depreciation and credit, as well as to increased cost of equipment, fertilizers, and irrigation, which represent the largest energy inputs on the farm.

Goal: Reduce crop production costs and related losses.

Objective 1: Improve genetic potential of plants for sustained productivity and nutritional value.
Further increases in crop yield through the application of genetic principles holds great potential for increasing productivity (production efficiency) and nutrition. This will be achieved by conventional breeding and selection technology aided by the newer techniques such as haploid production, protoplast fusion, and tissue culture.

Objective 2: Develop better ways to protect plants from weeds, insects, and disease.
In developed countries such as the United States, pests have been estimated to reduce potential agricultural production by roughly 30 percent and to destroy about 5

percent of the harvested commodities. Pest control strategies such as integrated pest management need to be developed for all major and minor crops, with regional adaptation that includes educational programs for their use. The search will continue for new and better biological control agents and other innovative combinations of pest management techniques.

Objective 3: Understand and improve the performance of plants in unfavorable physicochemical environments.
It is now apparent that plants have molecular means for acclimating to unfavorable environments, and that much of the plant response is under metabolic control. The effort to identify germplasm better adapted to adverse physicochemical environments should increase along with the development of improved screening techniques and elucidation of the genetic mechanism.

Objective 4: Collect and maintain a wide diversity of crop germplasm.
Lost germplasm cannot be replaced, nor can present technology predict what will be required. Therefore, it is necessary to continue to collect, evaluate, characterize, document and make available to breeders a diverse source of germplasm for continued crop improvement and to meet unforeseen threats.

Objective 5: Develop and transfer plant growth regulator technology for crop production.
The most basic aspects of crop growth, development, and reproduction are controlled by minute amounts of plant growth regulators. Research needs to develop a better understanding of these regulators, their mode of action, and the control of their production in order to produce transferable technologies.

Objective 6: Develop and transfer improved plant material and management systems for pasture and forage crops.
Livestock production costs from grazing lands and pastures can be reduced by using plant materials with improved quality, pest resistance, yield, and persistence; by planting legumes to add nitrogen; and by implementing management systems that improve efficiency. Development and use of simulation models should improve the management of these complex systems.

Trend Toward Larger Farms:
Accompanying recent production trends has been the increase in the number of larger farms. The raising of grain crops lends itself to large-scale monocultural production methods. These units take advantage of corporate structuring of assets, the use of larger equipment, and computer forecasting. They are increasingly capitalized and make extensive use of credit. Family farms and farms that produce specialty crops, while comprising smaller acreages, are also tending toward increased farm size.

Goal: Develop technologies appropriate to specific types of production systems (large monocultural grain systems, family farms, and small, high-value specialty systems).

Objective 1: Develop crop production systems for large monocultures and smaller family farms.
Cropping systems taking advantage of monoculture technologies and efficiencies of scale are more vulnerable to losses from environmental stresses and pests. Pest control scientists, geneticists, and extension specialists need to cooperate to develop and implement improved crop stress and pest protection technologies. Smaller farms may require more diversified cropping and education programs.

Objective 2: Develop models for measuring and improving resource efficiency in crop production systems.
Since computers are rapidly becoming a management tool for individual farmers, modeling concepts can provide important means for optimization and yield forecasting, as well as increasing the efficiency of resource use in crop production. Research and extension specialists need to develop software programs that forecast for specific crop systems the benefit of various inputs in terms of yield, income, capital requirements, and tax consequences.

Objective 3: Improve production efficiency and quality of small-acreage, high-value crops.
Research needs to emphasize ways to increase production and quality of small-acreage, high-value horticultural crops directly consumed by the population. Because of the high economic returns from these crops, advanced methods of irrigation, supply of nutrients, and hormone control of flowering and fruit sets are possible. An important component of this effort is the strengthening of extension programs which can then deliver new technologies to small farming systems.

Resources:
The 1983 resource base and projected change in scientist years (SY) or full-time equivalents (FTE) in **Crop Production and Protection** by 1988 assuming a zero or a 20 percent increase over the next 5 years.

		1988 projected change with:	
	1983	**zero increase**	**20% increase**
Research (SY)	4000	4003	4770
Extension (FTE)	3974	3894	4610
Higher Education (FTE)	2464	—	—

Research projections for Crop Production and Protection are that scientist years will remain constant using the zero increase assumption (redirection), and increase by 19 percent (1 percent below average) using the 20 percent increase assumption. Noncommodity-oriented biological technology and biometry, and production management systems for field crops are projected to receive the largest relative increases.

Extension projections for Crop Production and Protection are that full-time equivalents will decline slightly, about 2 percent, using the zero increase assumption (redirection) and increase by 16 percent (4 percent below average) using the 20 percent increase assumption. Use and conservation of soil and water, pest management and pesticide education, home horticulture, financial and marketing management related to crops, and cropping systems that increase productivity and efficiency are programs targeted for added emphasis within this category. Clientele for these programs include 4-H youth.

Combined Subject-Matter Resources

The relative changes among subject-matter categories are easier to comprehend when all categories are compared. The following tables display research and extension resources by subject-matter and with the 5-year projections using both the zero and 20 percent increase assumptions. Higher education resources are displayed by subject-matter and by academic category. Higher education resources are for 1983 and short-term projections of future change are unavailable.

The 1983 **Research** base and projected changes by 1988 are shown in Table 1. With no increase in support, resource changes among categories must occur by redirection. Soil, Water, and Air, Human Nutrition, and Agriculture and Resource Policy are projected to increase at the expense of Youth, Family, and Consumer Programs and Community and Rural Development. With an assumed 20 percent increase over the 5 years, Soil, Water, and Air and Human Nutrition increase 28 percent (8 percent above average) and Youth, Family, and Consumer Programs and Community and Rural Development are projected to increase 8 percent and 6 percent, respectively, below average. Resource projections for other categories indicate relatively less change.

Table 1. Present (1983) and projected allocation of scientist-years by 1988 and the relative change among categories with an assumed zero increase and with an assumed 20 percent increase in scientist years over the next 5-year period.

Subject-Matter Categories	1983	1988 projected change with: zero increase		20% increase	
	SY	SY	%	SY	%
Soil, Water, and Air	1003	1035	3	1284	28
Forest, Range, and Wildlife	1673	1667	—	2000	20
Crop Production and Protection	4000	4003	—	4770	19
Animal Production and Protection	2112	2101	—	2502	18
Processing, Marketing, and Distribution	1603	1598	—	1891	18
Agriculture and Resource Policy	516	528	2	622	20
Human Nutrition	328	334	2	420	28
Youth, Family, and Consumer Programs	256	240	-6	286	12
Community and Rural Development	92	88	-4	105	14
International Science and Education Programs	—	—	—	—	—
Total	11583	11594[1]		13880	

[1] The difference of 11 SY between 1983 and the 1988 zero increase results from rounding and the aggregation of data.

The allocations of **Extension** staff resources (FTE's) among the subject-matter categories are shown in Table 2 for the present (1983) and for 1988 projections using the zero and 20 percent increase assumptions. With no increase in support, the zero assumption, changes in the allocation among categories must occur by redirection. Projected allocations under this assumption (col. 2) are that soil, water, and air; forest, range, and wildlife; processing, marketing, and distribution; and agriculture and resource policy would increase substantially in percentage terms (col. 3). These increases would be offset by reductions in crop production and protection, youth development, and family and consumer programs. The declines expressed in percentages are smaller since the FTE bases for categories with projected reductions are much larger.

The projections to 1988 under the 20 percent increase assumption reflect emphases similar to those under the zero assumption with the range in percentage changes being somewhat wider (cols. 4 and 5). The same four categories which increased under the zero assumption are projected for increases well above the 20 percent average. FTE's in animal production and protection are projected to increase in percentage terms near the average, while the remaining categories show projected (percentage) increases which are modestly below the average.

Table 2. Present (1983) and projected allocation of extension full-time equivalents (1988) and relative change by subject-matter category with an assumed zero increase and with an assumed 20 percent increase in full-time equivalents over the next 5-year period.

Subject-Matter Categories	1983	1988 projected change with: zero increase		20% increase	
	FTE	FTE	%	FTE	%
Soil, Water, and Air	540	608	13	805	49
Forest, Range, and Wildlife	700	744	6	940	34
Crop Production and Protection	3974	3894	-2	4610	16
Animal Production and Protection	2430	2417	—	2903	19
Processing, Marketing, and Distribution	488	549	12	744	52
Agriculture and Resource Policy	314	338	8	452	44
Human Nutrition	1767	1771	—	2055	16
Youth, Family, and Consumer Programs					
—Youth Development	3023	2973	-2	3491	16
—Family and Consumer Programs	2627	2578	-2	3106	18
Community and Rural Development	1212	1203	—	1417	17
International Science and Education Programs	—	—	—	—	—
Total	17075	17075		20523	

Human resources in **higher education** are presented in Table 3. Projections of future resource allocation for higher education are unavailable.

Table 3. Estimated full-time equivalents devoted to teaching by higher education faculty and graduate teaching assistants in the food and agricultural sciences. Data are classified by academic category and subject-matter category.[1]

	Academic Category				
Subject-Matter Category	**Agriculture and Natural Resources**	**Forestry**	**Home Economics**	**Veterinary Medicine**[2]	**Totals**
		Full-time equivalents			
Soil, Water, and Air	684				684
Forest, Range, and Wildlife	185	876			1,061
Crop Production and Protection	2,464				2,464
Animal Production and Protection	1,351			1,932	3,283
Processing, Marketing, and Distribution	629		1,445		2,074
Agriculture and Resource Policy	710				710
Human Nutrition	79		1,760		1,839
Youth, Family, and Consumer Programs	0		3,403		3,403
Community and Rural Development	367		0		367
International Science and Education Programs	40		2		42
TOTALS	6,509	876	6,610	1,932	15,927

[1] Estimates were developed by HEP and based on the "Clemson University Survey of College Faculty in the Food and Agricultural Sciences, 1978/79" and the USDA-HEP "Survey of College Faculty in the Food and Agricultural Sciences, 1983."

[2] Data provided by the Association of American Veterinary Medical Colleges for the 1982/83 academic year.

NEEDS ASSESSMENT

Supply/Demand Projections

I. Draft Charter Language

There are many policy implications in the Needs Assessment projections. U.S. farmers will be increasingly dependent on growth in unstable export demand as domestic population and per capita consumption growth slows. Annual growth in export demand is projected to remain much slower through the year 2000 than in the 1970's. Growth in demand for U.S. production of some commodity groups is projected to lag well behind that of cereals and oilseeds.

Although Scenario C in the report is the most optimistic evaluated, it is based on yield increases deemed most probable at last year's Soil and Water Resources Conservation Act Symposium. In many cases these yields are already being achieved on test plots using existing, unadopted technology. In this scenario, the Needs Assessment projects that harvested acreage could be reduced by 55 million acres below the 1979-81 average and there could still be a tendency toward excessive supplies of major crops through the year 2000. Demand for U.S. production in the year 2020 is considerably more uncertain, indicating the need for continued support of the food and agricultural sciences.

Issues. How can these supply/demand projections be used in setting priorities? Do they help focus attention on certain commodity or problem areas? Is there a need for the Joint Council to place greater priority on environmentally desirable technologies (e.g. integrated pest management (IPM)) that may not significantly increase yields? Since the post-harvest share of costs will continue to grow (to 75% by the year 2000), should this area receive much greater priority to increase our competitive edge in current or emerging strong areas?

II. Additional Background

Traditionally, the system has concentrated on assuring an adequate supply of all types of food and fiber for any contingency. Considering potential future demand might help select priorities for national emphasis.

Resources for the Future (RFF) wrote an extensive chapter estimating supply and demand in the years 2000 and 2020 for the Needs Assessment Reference Document. It was a difficult task. To determine the need for U.S. production, it was first necessary to estimate world demand and supply. The uncertainties in these projections are great. Three factors must be considered: (1) population growth; (2) growth in incomes; and (3) national policies. Changing annual population or income growth estimates has a large impact on world food demand over several decades.

The report notes that we always lag in knowledge of current population trends and the recent tendency has been to overstate growth. World economic and income growth are difficult to predict one year ahead, much less two to four decades ahead. National policies, like the Soviet decision to purchase U.S. wheat, can have enormous impact.

The RFF study estimates demand for consumption rather than for nutritional requirements. The assumption is that the U.S. will not be giving food away on a large scale. National income growth will determine a country's ability to pay for food.

A key assumption in the study is that all regions of the world are expected to meet increased demand largely out of increased domestic production. Although demand growth is particularly large for some developing regions, this is where production technology has lagged. Consequently, the potential for productivity growth is greatest in these regions. This assumption limits the growth in international trade and the chance for increased U.S. exports.

While stressing the great uncertainties, RFF develops a likely scenario for the year 2000 in which U.S. oilseeds production would need to increase by 42%, cereals by 31%, and meat, milk and cotton by only 20%. The implied annual growth rates are well below those of the 1970's. Most of the growth in effective demand for U.S. oilseeds and cereals will come from foreign markets. However, almost all of the growth in demand for meat and milk will be in the domestic market. Estimates for the year 2020 are admitted to be exceedingly tenuous and are only provided for cereals and oilseeds, increasing by 69% and 93% respectively over current levels.

This demand scenario indicates that U.S. farmers will be increasingly reliant on unstable export markets. Factors outside U.S. control will increasingly determine the health of the farm economy.

The study next evaluates the U.S. ability to meet this demand. Supply Scenario A is an unrealistic one based on static technology. The increased demand could still be met by bringing 95 million acres into production. This approaches the 127 million acres judged available for conversion to soybean/feed grain production. Scenario C is the most optimistic one evaluated. As mentioned in the charter, this is based on most probable yield estimates from last year's RCA symposium. This could create a tendency for chronic oversupply, even while decreasing harvested cropland by 55 million acres. Scenario B is mid-range between the other two. It represents RFF's judgment about plausible growth rates based on available technologies, probable economic incentives for adopting the technology, and expansion of cropland to less productive acreage. This Scenario would require an increase of 25 million acres of harvested cropland.

The Needs Assessment reflects these supply/demand projections to some degree. There is a growing recognition that increased production no longer has to be the dominant goal. There is emphasis on socially appropriate technologies. Reducing production costs is now widely accepted as an important goal to provide some relief to farmers. The report recognizes that the export boom of the 1970's will not be repeated.

There is, however, no analysis of the implications of much lower demand growth for U.S. meat, milk and cotton. This could mean that national policy should favor research and extension efforts on cereals and oilseeds, or on specialty crops with potential for significant domestic or export markets. The greater demand should improve economic payoffs for such research and hasten producers' adoption of the new technology. But the Needs Assessment Reference Document chapters on each major agricultural science area are based almost exclusively on technological needs and opportunities. Possible demand is rarely mentioned. One exception is the chapter on Animal Production and Protection, where lack of profitability in meat production is candidly discussed. The chapter recognizes that the main impediment to increases in animal production efficiency is lack of economic incentives. Additional demand from exports or new products is seen as the way to stimulate additional on farm efficiency gains. But there is no mention in this chapter of the relatively low projected growth in demand for U.S. meat through the year 2000. This could indicate that the very promising animal technologies will either not be adopted or will lead to chronic oversupply and increasingly poor profitability in the meat industry.

With significant technology breakthroughs in animal production, far fewer producers could be needed by the year 2000 to meet effective demand. This has already occurred in the poultry industry, without improving long-run profitability. The increase in poultry production has reduced demand for other meats, limiting profits of other livestock producers. The briefing paper in the "Biotechnology/Social Benefits" section notes that a single new biotechnology product, bovine growth hormone, could result in a 15% to 40% increase in every cow's milk production. This might require a 40% reduction in the national dairy herd. These types of major program implications should be investigated at the June hearings. With increasingly tight funding, resources should be allocated to research and extension areas that have the greater potential payoff.

Additional background material is provided on the following pages.

NEEDS ASSESSMENT REFERENCE DOCUMENT

Joint Council
January 1984
p. 51

Historical and Projected Annual Rates of
Growth of Total Production, U.S.

(Percent)

Commodity	1969/71 - 1979/81	1979/81 - 2000
Cereals	3.7	1.3
Oilseeds	5.7	1.6
Meat	1.4	0.9
Milk	0.9	0.9
Cotton	3.1	0.9
Forest Products	1.2 1/	2.2

1/ Rate of growth for the period 1970-80.

NEEDS ASSESSMENT

Pesticide Use

I. Draft Charter Language

Pesticide use is mentioned as a concern in the Needs Assessment. The report calls for more targeted chemical systems with fewer environmental hazards. Base programs in biological control of pests are recognized as important. Biotechnology breakthroughs may offer long term solutions to some pest problems. However, the report seems to accept projections of greater use of pesticides in the future, largely due to increasing herbicide use as more farmers adopt conservation tillage. Although it recognizes gaps in knowledge about long term effects of even present application rates, the report does not emphasize understanding the effect of pesticide use on long term soil fertility as a major needs area. The Joint Council's FY 1985 priority on Sustaining Soil Productivity is focused on minimizing erosion and does not emphasize understanding pesticide effects.

Public concern about pesticides is increasing rapidly. A recent survey, completed before most of the EDB scare, indicated that 77% of Americans consider pesticide residues to be a serious hazard. Cholesterol, salt, sugar and additives all concerned less than half of those polled. Whether accurate or not, such public concern engenders distrust of the historic accomplishments of the publicly supported agricultural sciences.

Issues. Do the public concern and the possibility of very stringent pesticide regulation by the year 2000 require greater emphasis on near term alternatives? What is the current status of research on pesticide effects on soil fertility? Have biocontrol and IPM efforts been deemphasized as budgets tighten? What is the proper Extension role in educating the producer and the public about pesticide use and alternatives? What are the alternatives to increasing herbicide use as conservation tillage acreage grows?

II. Additional Background

One major gap in the Needs Assessment report may prove to be the lack of emphasis on understanding the impact of pesticides and reducing their use. The term "pesticide" is used broadly to include insecticides, fungicides, herbicides and nematicides. Some pesticides will always be necessary. However, the research and extension system might gain greater public confidence by emphasizing development of alternatives to pesticides. This might allow the system to adjust gradually to possible restrictions on pesticide use imposed by an increasingly urban Congress. The survey director of the President's reelection campaign has warned farmers that the explosive issue of pesticides has the potential to be another Three Mile Island.

The basic issues are:

(1) Do pesticides have long term negative effects on farm productivity that might offset the short term benefits?

(2) Regardless of the on-farm benefits, what are the prospects for reductions in pesticide use to achieve off-farm benefits (e.g. improved water quality, lower food residue levels).

These are discussed in the following two sections.

On-Farm Effects of Pesticide Use

Many scientists assume that regular pesticide use is essential for high sustained yields. DuPont's George Levitt credits herbicide use with an additional 60 billion loaves of bread world-wide each year. Such estimates are impressive but do not consider alternative ways of achieving these gains.

Pest resistance to chemical pesticides is an increasing concern. There are now about 430 insects, 100 diseases, and 36 weeds resistant to pesticides. Like penicillin, overuse of pesticides hastens the development of resistant pests. Heavy pesticide use can also cause unanticipated side effects, as evidenced by cotton budworm and pink boll worm infestations after chemical suppression of boll weevils. Sometimes soil microorganisms can actually break down pesticides before they take effect. Mobay recently had to recall Amaze, a corn rootworm insecticide, for this reason and make large payments to farmers for damages.

Many press articles criticize pesticide and artificial fertilizer use for their harmful effects on soil fertility. Often these articles include testimonials from farmers about the damage to soil life caused by chemicals. Actually, very little is known about the chemical and biological properties of soils as they relate to soil fertility. It is hard to answer critics of conventional agriculture until the public research system understands basic soil-plant-nutrition relationships in various chemical and non-chemical management systems. Recent ARS initiatives may slowly begin to overcome this knowledge gap. ARS agreed to locate a scientist at the Rodale Research Center in April for at least one year. His assignment is to evaluate the Rodale organic soils data base to see if it is consistent with ARS' crop/soil models. In addition, ARS allocated $550,000 (9%) of its FY 1985 specific research increase request to additional research on basic soil fertility (ref. attached summary). This is an initial step in establishing a coordinated network of ARS projects nationwide. Initially this expanded research would not include a major focus on effects of pesticide use on soil fertility.

Current research findings are mixed. The 1980 USDA organic farming study found that pesticides can kill soil microorganisms and harm crops when applied at excessive rates. However, when properly applied, most pesticides seldom reach soil concentrations greater than 2 or 3 parts per million, which should be safe unless synergistic interactions between pesticides and their degradation products are occurring. Residual pesticides could have a long term chronic effect on beneficial soil microorganisms. Soil fungicides and fumigants are deliberately applied at high rates, resulting in partial soil sterilization and longer term effects on soil life.

Soil organic residue levels and depth of tillage may influence soil fertility more than pesticides. Organic farmers and conservation tillage farmers avoid deep plowing and maintain high organic residue levels. These practices add organic matter to the soil and reduce the oxidation of vital nutrients. An ARS scientist mentioned a minimum till research plot in Ohio that has had conventional chemical inputs for 20 years. He reports the soil is rich and filled with earthworms. Yields are increasing.

It is apparent that current' knowledge of pesticide effects on soil fertility and crop productivity is fragmentary or anecdotal. More research needs to be done before the public can be convinced that pesticides are vital for farmers. More Extension effort is needed to encourage farmer adoption of proven techniques to reduce pesticide use.

Efforts to Reduce Pesticide Use

In response to increasing public concern, the public research and extension system emphasized Integrated Pest Management (IPM) as a way to reduce pesticide use. IPM has become a very loose term covering most pest control strategies, including scouting fields, timing of planting and harvesting, biological control of pests by introducing predators, and use of resistant crop varieties. IPM has been successful in reducing pesticide use on Texas cotton but has had little success elsewhere. Despite the popular appeal of IPM, Sylvan Wittwer, former Director of the Michigan Agricultural Experiment Station, reports that:

> Integrated pest management in the broad sense and even with individual crops is still only a concept. No system has yet been widely accepted by growers that does not use chemicals. Possible exceptions are those involving organic farming. Integration of disciplines at the institutional level has not yet occurred. It now appears that integrated pest management, because of institutional constraints and funding strategies, will not, in reality, happen in this generation.

Earmarked Federal funding for IPM research and extension has been one way of encouraging universities to overcome these institutional and disciplinary barriers. Faced with increasing budget constraints, USDA has proposed terminating these earmarked grants in recent years. A $480,000 CSRS Special Grant for biological pest control was terminated in FY 1984. Proposed terminations of a CSRS IPM Special Grant ($3.1 million) and Extension pest management grant ($7.5 million) were restored by Congress in FY 1984. The terminations have been proposed again in FY 1985. If these are not restored, a Federally earmarked IPM program will no longer exist.

Conclusion

Pesticide use is becoming a major public concern. The research and extension system should anticipate additional restrictions by moving quickly to find ways of reducing pesticide use. The economic benefits of these techniques must be proven to farmers. Reducing or eliminating pesticides for many uses promises to reduce farmers' production costs, maintain environmental quality, and alleviate public fears. However, there is a danger that tight budgets will force research on IPM and pesticide effects on soil fertility to the back burner. These are not Joint Council priority areas. This could leave agriculture unprepared for a series of reversals like the recent EDB cancellation.

FARMERS: AMERICA'S 'MOST SOLID GROUP'

RUND WARNS DELEGATES OF PESTICIDES' EXPLOSIVE 'THREE MILE ISLAND' POTENTIAL, NEED FOR POSITIVE PUBLIC INOCULATION

"The potentially explosive issue of pesticides could become as nationally prominent as nuclear waste," Charles Rund, director of survey research for the Reagan-Bush campaign, told the audience at the closing breakfast of the Council's annual meeting in Sacramento.

"By the time agricultural chemicals are dealt with, they are going to be as well known as nuclear power," he said. "They have the potential of Three Mile Island."

Rund characterized pesticides as a "controlled" issue right now and he said this was the time for agriculture to "get the word out" and deal with pesticides in a positive vein before they gain widespread public attention.

"If you see an issue that could become negative, you must be positive first," he said, likening the process to inoculating the public so it will be in a better position to understand the situation when it heats up.

"If you have to do that after the fact, it makes it a lot more difficult for you to speak on the issue," he added. However, when an issue is already cast in a negative light, Rund said there is little choice but to fight a defensive battle at some point.

In a fast-paced presentation, Rund surveyed many issues at work in the arena of public opinion. He said the public's perception of farmers is "the most biased view that I have ever seen in my life compared to reality."

He reported that his firm did a major study of American farmers in the Midwest and found them to be among the most educated people in the country, yet, he said, the public still bases its image of the farmer on the past.

In contrasting farmers to the urban public, Rund said, "you're the most solid group of Americans today. You know what you're doing because you control all levels of the production cycle."

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ARS SOIL FERTILITY RESEARCH

FY 1985 Budget Increase Request

An increase of $550,000 to devise methods for maintaining and improving soil fertility and the chemical and biological properties of soils for optimum crop production ($9,758,000 available in FY 1984.

Need for Change. For at least two decades, inadequate attention has been given to basic research on soil fertility and the chemical and biological properties of soils as they relate to optimum crop production and resource conservation. As crop yield potentials are increased, new research is needed on soil-plant-nutrition relationships so that soil fertility and its management are optimized and do not become barriers to continued increases in future U.S. crop yield levels. New research opportunities have opened up because of recent scientific advances in instrumentation, and improved understanding of soil chemistry, microbiology, biochemistry and plant physiology, and new agricultural production systems including conservation tillage and organic farming.

Nature of Change. The requested increase will be used to establish a coordinated network of ARS projects across the country to investigate biological, chemical, and physical interrelationships within soils comprising a spectrum or variety of agricultural production systems, including organic farming. New research will be directed toward the development of improved understanding of: 1) chemical, biological, and physical factors within the soil, including the role of microorganisms, at the soil-plant-root interface that influence plant nutrient uptake; 2) mechanisms of and factors affecting plant nutrient movement through the soil to the root surface, including the role of environment, soil organic matter, and root morphology; 3) factors influencing root cell membrane permeability, integrity, and function for nutrient uptake and retention; and 4) how agricultural chemicals interact with and influence soil biological, physical, and chemical relationships.

NEEDS ASSESSMENT

Technology and Farm Structure

I. Draft Charter Language

The Needs Assessment acknowledges that most new technologies will result in greater volume for early adopters and a reduced number of farms. Computer use will give large farms an additional competitive edge. The report does call for an understanding of the relationship between technology and farm structure, and recommends assessment of the long term implications of present trends.

Issues. What types of research and education would help encourage a diverse, profitable agricultural production sector? Should this have a high priority? Should county agents work more with limited resource farmers as the latest technologies are increasingly packaged as integrated systems in software form for the larger producers?

II. Additional Background

The Needs Assessment discusses farm adjustment problems caused by new technologies and national policies. Solutions to these complex problems are not proposed. The report states that social scientists do not know enough to meet the present and future challenges of policymaking. Accordingly, the report lists a lengthy agenda of agricultural policy research needs. These are summarized in the attached excerpts from the Five-Year Plan.

Congress might question whether the serious problems facing agriculture can be put on hold until social scientists are more comfortable predicting the consequences of policy choices and new technologies. The trend toward fewer and larger farms accounting for most of the production is well known. In 1981, 5% of farms accounted for half of the output. The 24% of farms classified "medium-size" produced an additional 38%. Small farms (71%) produced only 13% of the total. Further delays in encouraging a profitable and diverse farm sector will ensure continuation of this trend. While the additional knowledge needs are great, enough is known for Congress to provide leadership by establishing long term policies designed to ensure the health of the farm sector.

It is probably unfair to ask the science and education system to anticipate society's inchoate goals for an optimal farm sector. Despite the frequent references in the Needs Assessment to more emphasis on socially appropriate technologies, bench scientists and national leaders of the system are often uncertain about what research directions will be socially appropriate. Commodity programs, credit policies, and tax laws have a greater impact on the structure of agriculture than research and extension. The larger forces which favor larger farm units are, in effect, society's statement concerning a socially appropriate farm structure. Ruttan has written that "technical change is such a blunt instrument of reform." He goes on to say that "A nation's agricultural research budget can be a powerful instrument for expanding its capacity to produce food and fiber, but it is a relatively weak instrument for changing income distribution in rural areas." However, research leaders can be expected to study the possible effects of different research priorities and inform the political system. Ultimately, the political system must choose the type of farm structure desired and reduce the many policy biases against small and medium-size farmers. The research and extension system would then have more incentive to address the special needs of these farmers.

The new emphasis on reducing production costs will benefit small and medium-size farms more than research that results in capital intensive technologies. Research on regenerative agricultural systems is an area that could result in a significant reduction in production input costs for many farmers. Emphasis on biotechnology breakthroughs packaged in seeds could hasten or slow the trend to large farms, depending on how the breakthroughs are commercialized. The improved seeds will become additional vital production inputs that could increase or decrease the needs for other inputs. A separate paper examines the potential public benefits of biotechnology.

Extension may stake out a larger role working with small and medium-size farmers by default. The 100,000 farmers who produce half of farm output will increasingly have access to information sources beyond the county agent. Extension could play a valuable role in stabilizing the farm sector by placing greater emphasis on teaching sound financial management and cost-reducing techniques to small and medium-size farmers. These farmers may often learn about computers from Extension. Extension agents can help provide alternatives to the "bigger is better" syndrome. High debt services may not be a good risk in view of the uncertain and cyclical demand for agricultural products projected over the next two decades.

In summary, the Needs Assessment raises questions about the relationship between technology and farm structure. However, these needs were not addressed in the FY 1985 Priorities Report. Because of the many other needs and opportunities in the Needs Assessment, these research items will probably not be highlighted in the upcoming FY 1986 Priorities Report. Congress should question the system's plans to consider the farm adjustments that will be caused by future technology directions.

The following pages contain additional background material.

Five-Year Plan for the Food and Agricultural Sciences

Joint Council on the Food and Agricultural Sciences May 1984

(Excerpts from pp. 28-29, part of the Agriculture and
Resource Policy chapter)

Size, Cost, and Asset Distribution of Farms:
Agriculture in the United States is evolving from a way of life into a large-scale business. In 1981, agricultural production units were made up of 112,000 large farms, which produced 49 percent of the U.S. farm output; 582,000 medium-size farms, which produced 38 percent of the output; and 1,742,000 small farms, which produced 13 percent of the output. Income based on farm sales tends to be concentrated in the larger farms, although off-farm income has tended to raise the total income of smaller farms. Policy actions that intervene in the market influence the return to farming; the effects include an altered distribution of income across farm sizes and types. Commodity support policies inevitably tie their benefits in some way to production, implying that they will not be able to concentrate on farms whose needs may be greatest.

Goal: Determine long-term adjustment needs of large, medium, and small size farms.

Objective 1: Improve understanding of the factors affecting individual farm decisionmaking.
The interplay of agricultural and other national policies (e.g., tax and credit policy) as well as greater participation in world markets has expanded the variables affecting individual farm decisionmaking. These changes have exposed farmers to greater business risk and uncertainty. Improved understanding of how farmers respond to changes in policy, as well as how they manage risk and uncertainty, is needed.

Objective 2: Identify the consequences of alternative policies.
As policies are established that affect the size, cost, and asset distribution among farms, a host of new issues will emerge in public debate. Particularly important will be the implications of changing technology—some of it developed through public support.

Objective 3: Provide improved research, behavioral studies, and data that are basic to future policy considerations.
Research and data are needed which better describe and analyze the heterogeneous farm sector, including economic measures of farms by size, commodity types, location, and debt service. Behavioral studies which explore the management decision processes of various kinds of farms are also needed in order to anticipate their responses to economic and policy signals.

Objective 4: Provide knowledge through extension education on public policy and other factors related to farm size and financial condition.
Extension education plays a key role in preparing tomorrow's farmers, consumers, and policy makers to deal with changes in the nature of the U.S. agricultural economy and in developing policies that meet public needs. Extension also plays a related role in educating producers, consumers, and others about the farm sector, particularly its cost and return structure, implications for financial viability under various economic and policy settings, and alternative public responses and their implications.

EXTENSION

Accountability and Evaluation

I. Draft Charter Language

Extension is aware that program benefits must be proven to officials who are often unfamiliar with the CES. The Federal partner has been actively coordinating the establishment of a national evaluation and accountability system. This includes national evaluations, state evaluations, a four-year cycle of state planning, and a new reporting system.

Issues. What progress has been made in establishing the costs and benefits of selected programs? Will this effort establish the relative merits of different programs? Does the new management system indicate significant state response to Extension in the 80's priorities in each program area? What has been the Federal Extension role in reviewing the Four-Year State Plans? What types of cooperation in future program activities of the 1890 and 1862 institutions are evident in the Four-Year Plan?

II. Additional Background

In response to concerns expressed in USDA's 1980 national Extension evaluation study, the 1981 GAO study on Extension's mission and role, and the 1982 DORFA hearings, Extension made a major commitment to improved program accountability and evaluation. This received a major emphasis in the Extension in the 80's report (ref. attached page from the report).

The greatest progress has occurred in the area of accountability. Previously, each state submitted an annual plan of work for USDA review and approval. The voluminous plans coming in on an annual cycle usually did not receive extensive review. The states did not see the plans as important policy tools. Federal Extension has made the following changes to increase the usefulness of the state plans.

(1) The plans of work are now on a four-year cycle. This encourages greater effort on state long range planning and more intensive Federal review of the plans.

(2) Each state has selected its own reporting categories, usually 50 to 60 programs. These are very similar from state to state but each state may develop special programs, such as sheep raising.

(3) Each state program is presented on one or two pages, specifying objectives, plan of action, evaluation plans, staff contacts, estimated impacts, and staffing plans (ref. attached sample).

(4) All state programs (approx. 3,500) are on the computer and can be accessed nationwide. The file can be searched by key words to pull out all programs where a particular word appears anywhere in the text. This should increase sharing between states.

The Federal staff questioned 60% (about 2000) of the state programs. This generally involved a 10 to 15 page letter to each state, questioning insufficient benchmark data, unclear objectives, failure to quantify expected impacts, unclear target audiences, etc. Federal comments do not question the need for any programs, because of the wide program latitude in the statute. Federal comments occasionally suggested improved ways of delivering programs.

In addition to the Four-Year Program Plans, the on-line Accountability and Evaluation System has separate files for Impact Study plans, Accomplishment Reports and ARS Research Results of interest to Extension. Samples of these are attached.

Federal Extension contracted with Maryland to develop guidelines for good evaluation studies and led training sessions for state staff. The 235 state and 5 national level evaluations for the 1984-1987 planning cycle should be solid evaluations based on the new guidelines. The evaluation plans are synchronized with the Four-Year planning cycle. This means the findings will not begin to influence programming decisions for some time. Also, these initial studies will focus primarily on identifying program impacts. Assistant Secretary Bentley is now favoring equal weight on program improvements for evaluations during the next planning cycle. The evaluations may not directly affect state resource allocation decisions. There is no attempt to directly compare costs and benefits of different programs. Comparisons will be difficult due to the diversity of evaluation formats, which vary depending on type of program, program delivery method, and state evaluation expertise.

The Four-Year Plans of Work are a tool to encourage greater cooperation between 1862 and 1890 institutions. Each Southern state had to submit a unified state plan, although two identical program titles were often listed, one for the 1862 and one for the 1890 institutions. The shared reporting requirements, joint long-term resource allocation projections, and joint impact studies should continue to foster closer ties between the two institutions.

In summary, the new Accountability and Evaluation System is a promising tool. The emphasis has been on accounting for use of resources. The evaluation component will augment this accountability responsibility by improving the analysis of program impacts. It will not answer the more fundamental policy questions concerning Extension's appropriate mission and target audiences.

PROGRAM EVALUATION AND PUBLIC ACCOUNTABILITY *

The Cooperative Extension Service has always had a national system under which the states and counties submit to ES-USDA annual plans of work and statistical and narrative reports of accomplishments and use of time. We commend the leadership of ES-USDA and the national Extension Committee on Organization and Policy for developing a new national system for Extension accountability and evaluation (the A/E system). ***After extensive study and research, the special A/E task force published a report.*** [1] ***We endorse that report. Recommendations in it constitute a means of improving the accountability and evaluation of Cooperative Extension.***

Evaluation, which is constant and ongoing, has generally been effective at the county levels where most Extension programming takes place. County committees meet frequently with Extension agents in planning and evaluating programs. Community residents constantly evaluate Extension work in a less formal manner as they participate in programs, read or hear about them through the public media, and express their reactions to county and state officials. Private sector contributions and volunteer efforts are indicative of the value these people place on Extension programs.

Most county governing boards require regular reports concerning Extension programming and annually evaluate staff and programs as a means of determining the amount of financial support they wish to provide. These mechanisms notwithstanding, there is increasing evidence that local units seek more effective procedures for formal program evaluation.

Many states have evaluation specialists on their staffs. These specialists do more than conduct studies of program impact and methods; they assist staff at county and state levels in building evaluation into program operations. ***Because evaluation is important to Extension's effectiveness, we encourage all states to allocate adequate resources for developing improved evaluation methods.*** State legislators and executive branch officials increasingly demand "impact" data and information on use of funds. State evaluation specialists can assist with this function. The committee recognizes, however, that there are effects of Extension education that do not lend themselves to hard data evaluation.

As America grows more urban, an ever-larger proportion of officials in government has no rural experience and hence relatively little knowledge of Cooperative Extension. This trend can be expected to continue. Thus, fewer public decision-makers will be acquainted with the Service, its goals, impact, and potential.

Extension must better understand what others expect of it. The Cooperative Extension Service has not done an adequate job of reporting to or relating with the general public or state, county, and national decision-makers. Cooperative Extension must involve the public and decision-makers in Extension evaluation efforts; by such activity, these people will come to understand Extension better.

The extensive surveys made by this committee strongly substantiate the need for Cooperative Extension to find ways and resources to report Extension programs and results to the urban public and to public decision-makers. These target groups include governors and their state agency leaders; state and national legislators and their staffs; organizational leaders and their boards; mayors and county executives and their staffs; and top university officials and their staffs. This committee believes that Cooperative Extension is vitally important to America and has tried to demonstrate this belief in this report. Given this premise, ***it is incumbent upon Extension to give serious attention to informing the public about its activities. A better informed public will make better decisions about this important service.***

* Excerpt from the "Extension in the 80's" report.

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[1] "Report of the National Task Force on Extension Accountability and Evaluation System."

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>NARS
*******************************
**        WELCOME TO         **
** THE EXTENSION A&E SYSTEM  **
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  CODE        SERVICE

*   1A          Impact Studies - Plans
    1B          Impact Studies - Reports
*   2A--        Accomplishment Reports - FY 81
*   2B          Accomplishment Reports - FY 82
*   2C          Accomplishment Reports - FY 83
*   3           Four Year Program
                and Evaluation Plans
*   4           Analyst Briefs
*   5           A & E Training Materials
*   6           Research Results

Type "INFO MORE" for more instruction.

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A&E = Accountability & Evaluation

POW = State Four-Year Plans of Work - 1984-1987.

IOWA'S MAJOR PROGRAMS 1984-1987

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Enter keywords or Read or Scan
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1 AUGUST 31, 1983
IA44 PESTICIDE IMPACT ASSESSMENT IOWA

2 AUGUST 31, 1983
IA43 PESTICIDE APPLICATOR CERTIFICATION IOWA

3 AUGUST 31, 1983
IA42 INTEGRATED PEST MANAGEMENT IOWA

4 AUGUST 31, 1983
IA41 IOWA PUBLIC POLICY EDUCATION

5 AUGUST 31, 1983
IA40 IOWA SMALL BUSINESS MANAGEMENT AND DEVELOPMENT

6 AUGUST 31, 1983
IA39 IOWA EXPANDED FOOD AND NUTRITION EDUCATION PROGRAM

7 AUGUST 31, 1983
IA38 LEADERSHIP AND ORGANIZATIONAL DEVELOPMENT IOWA

8 AUGUST 31, 1983
IA37 IOWA HOME ENERGY CONSERVATION

9 AUGUST 31, 1983
IA36 IOWA RESOURCE MANAGEMENT TO ACHIEVE FAMILY GOALS

10 AUGUST 31, 1983
IA35 IOWA 4-H COMMUNICATIONS

11 AUGUST 31, 1983
IA34 IOWA 4-H AUDIENCE EXPANSION

12 AUGUST 31, 1983
IA21 COMMUNITY ECONOMIC DEVELOPMENT IOWA

13 AUGUST 31, 1983
IA33 IOWA STRENGTHENS LOCAL 4-H UNITS/CLUBS

14 AUGUST 31, 1983
IA32 IOWA 4-H VOLUNTEER DEVELOPMENT
```

44 program blocks constitute the total Iowa Extension program. Text from each program can be called to the screen to see the 1984-1987 Plan of Work.

30 more state programs ↓

STATE PLAN OF WORK AND EVALUATION PLAN
THURSDAY AUGUST 31, 1983

IA05 SOIL CONSERVATION SYSTEMS, IOWA

SITUATION DESCRIPTION: Soil erosidn is a major problem in Iowa and has been increased by intensified row crop production. Traditional erosion control practices are effective but unacceptable to many land managers. Conservation tillage has been demonstrated to be the most cost effective erosion control practices for cropland. However, combinations of proper conservation tillage techniques and traditional practices are needed to reduce soil losses to tolerance values. Acceptance and adoption of conservation practices require educational efforts to present supporting technology and continued cooperation with state and federal agencies.
PROGRAM OBJECTIVES: 1. To have 75% of the Iowa public recognize the long-term social and economic value of reducing soil erosion. 2. To increase the understanding of alternative soil conservation systems and to encourage the most cost-effective system for erosion control. 3. To increase the number of acres using conservative tillage by 1987 to a value 30% greater than a 1982 baseline value.
PLANT OF ACTION: Meetings, demonstrations, and tours will be held to increase understanding of soil conservation problems and solutions. Mass media and audience recruitment will develop farmer and public awareness. Conservation systems will be explained through publications, slide-tape sets and other techniques. Professional staff training will improve assistance for landowers and other clientele. Program linkages with SCS, IDSC, local SCDs, 4-H and other youth organizations will be used. Innovative methods will include computer-assisted programs. Use of mass media, including radio, public and cable TV, newspapers, and farm publications will also be used to create awareness. Support groups such as "no till" clubs will be encouraged.
PLANS FOR EVALUATION: A formal evaluation program will be initiated in 1983 to measure changes in soil conservation activities that result from extension educators over a four-year period. Baseline data to assess awareness and acceptability of soil conservation systems will be obtained. Public, agribusiness, and farm operator groups will be surveyed to determine changes in knowledge, skills and aspirations regarding conservation problems and solutions resulting from extension efforts.
*CONTACT
CONTACT PERSON: VIVAN M. JENNINGS, ASSOCIATE DIRECTOR
108 CURTISS HALL, COOPERATIVE EXTENSION SERVICE
IOWA STATE UNIVERSITY
AMES, IA 50011
515/294-7801

(cont.)

*KEYWORDS
IA05, 1984, IOWA, SOIL CONSERVATION SYSTEMS, CONSERVATION TILLAGE, CROP PRODUCTION, SOIL EROSION, EROSION, NO TILL, PUBLIC AWARENESS, FARMERS, LANDOWERS, YOUTH, PROFESSIONAL STAFF, AGENCIES, COMPUTER ASSISTED PROGRAM, DEMONSTRATIONS, MEETINGS, NEWSPAPERS, PUBLICATIONS, RADIO, SLIDES/TAPES, TOURS, NATURAL RESOURCES

*ESTIMATED IMPACTS

SOIL EROSION REDUCED	TONS/ACRE OF TOTAL SOIL LOSS IN TONS REDUCED
ACRES IMPACTED	INCREASE IN LOCAL CONSERVATION TILLAGE SURVEY, ACRES INCREASE IN PUBLIC AWARENESS OF VALUE OF SOIL EROSION CONTROL
COST AND ENERGY REDUCTION	REDUCTION OF TOTAL PRODUCTION COST/ACRE OR FUEL EQUIVALENT GALLONS/ACRE

*ESTIMATED FTE

	Prof	Para	Vol
1984	15.1	0	
1985	15.0	0	
1986	14.9	0	
1987	15.0	0	

*REPORTING PLANS

	Accomp.	St. Impacts
1984		
1985		
1986		
1987		

*SCOPE

Co. in St.	100	In Program	94

--R 1

IMPACT STUDIES - PLANS
WEDNESDAY AUGUST 31, 1983

IA45IS Program Evaluation: Iowa Conservation Tillage

JUSTIFICATION: Soil erosion is a major problem throughout the state. Although conservation tillage may not provide as many short term economic advantages associated with other farming innovations, it is an effective way to combat erosion. Each year during FY 84-87 some 16 fte staff units will be devoted to soil conservation programming.

IMPACT STUDY OBJECTIVES: This evaluation will assess how well area and county programming efforts match erosion vulnerability areas in the state. In addition, it will assess how well the major program objectives are being met. These objectives include increasing understanding of alternative tillage systems and increasing the adoption of conservation tillage practices by farmers in the state.

RESOURCES INVOLVED: An eight member committee of state, area and county staff have designed a study to measure Extensions impact of the objectives stated above. During FY 84-88, some 216 professional staff days and 280 support staff days will be allocated to conservation tillage evaluation. Other anticipated costs include $2,000 for data collection and an additional $2,000 for current expenses.

METHODS AND PROCEDURES: The evaluation will include a series of phases. A variety of data sources will be used including Extension administration records, industry records, practice estimates by other agencies, content analysis of public meeting materials, a random sample survey of 2,300 farm operators in the state, and a purposeful sample survey among Extension programming from other conservation tillage education efforts. The first baseline data collection will be August, 1982=3 with a one-year and a three-year follow up.

*CONTACT

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CES
Iowa State Univ.
Ames, IA 50011
(515) 294-8397

*KEYWORDS

IA45IS, IOWA, 1862, 1984, 1987, AUGUST 1983, AUGUST 1987,, CONSERVATION TILLAGE, MINIMUM TILLAGE, SOIL EROSION REDUCED, PRACTICE ADOPTED, ACRES IMPACTED

Portion of ARS Research Results file, now available on-line to all state extension offices through the Accountability & Evaluation System.

Lists new ARS findings, under the keyword "corn", which could appear anywhere in the full text.

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[corn]
Searching - Please wait...
    9 Reports contain the above keywords

Enter keywords or Read or Scan
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1 APRIL 4, 1984
ARS106 Present Herbicide Application Technology with Sprinkler Irrigation
       (for corn, peanuts and soybeans)  (RELEASED 3/84)

2 APRIL 4, 1984
ARS94       Efficacy of M-9580 as a protectant for corn and wheat against the
            lesser grain borer and maize weevil (RELEASED 3/84)

3 MARCH 28, 1984

ARS71  Amino Acid Content in Selected Breakfast Cereals (first report of
       quantity and quality differences in .1 Brands) (Released 3/84)

4 MARCH 28, 1984
ARS69       A Review of In-transit Shipboard Fumigation of Grain-Methodology,
            Efficacy and Safety  (Released 3/84)

5 MARCH 28, 1984
ARS46       Nitrogen Availability and Uptake Varies by Sewage Sludge type
            in Soils Five Years After Incorporation   (Released 3/84)

6 MARCH 28, 1984
ARS45       Soil and Crop Response to Nitrogen Fertilization of Soil
            Containing Decomposed Sewage Sludge (Released 3/84)

7 MARCH 28, 1984
ARS40       New and Future End Uses for Farm Products (corn, soybeans and
            crambe) (Released 3/84)

8 FEBRUARY 27, 1984
ARS14  (Effect of natural and artificial silicates in lamb rations).
       Response of Growing Lambs to Clinoptilolite or Zeolite NaA Added to

9 FEBRUARY 3, 1984
ARS09        Utilization of Municipal Sewage Sludge and Wastewater Effluent
             on Agricultural Land in Minnesota (Municipal Sewage vs.

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--R 7

RESEARCH RESULTS
WEDNESDAY MARCH 28, 1984


ARS40       New and Future End Uses for Farm Products (corn, soybeans and
            crambe) (Released 3/84)

The State of Illinois produces tremendous quantities of corn and soybeans.
These crops are sources for starch and soybean oil, which have important
applications as feedstock for a wide range of industrial materials as well
as food and feed products.  As a result of research at the Northern
Regional Research Center, new and growing markets for these feedstocks are
very likely to develop.  For example, new starch products can be used for
making rigid foam products, water-soluble laundry bags, biodegradable
agricultural mulch films, powdered rubber, absorbents for removal of heavy
metal contaminants from process water, encapsulated pesticides, and
high-capacity absorbents for water and body fluids.  From soybean oil,
products include new types of coatings, engineering thermoplastics, new
plasticizers for vinyl plastic clothing items and automotive upholstery,
and new types of polymeric materials.  New oilseed crops such as crambe
could be grown in Illinois to satisfy growing needs of industry for
vegetable oil-derived materials.
*KEYWORDS
Renewable Resources, Plastics, Soybean Oil, Starch, Corn, Utilization
*CONTACT
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Oilseed Crops Laboratory, NRRC-ARS-USDA
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REVISING THE EXTENSION FORMULA

I. Charter Language

The Extension in the Eighties report called for a review of the Smith-Lever formula, which has not changed since 1963. The current formula does not recognize Extension's broadened clientele or special mission to work with commercial farmers. A Special Projects factor could stimulate innovation and regional cooperation, both of which are essential as budgets tighten.

Issues. What are the arguments for and against a formula change in the next Farm Bill? Should the CES mission be reflected in the formula? Will a formula change improve budget treatment of the formula or only promote a more equitable distribution of funds that are not growing in real terms?

II. Additional Background

An ECOP Task Force was created to consider alternative formulas. It made a series of recommendations to ECOP in November. A motion for ECOP endorsement of a revised formula was recently tabled by the state directors.

In abbreviated form, the recommendations were:

(1) grandfather the base
(2) permit 3(d) earmarked funds to be merged with the base without changing their current distribution.
(3) continue to reserve 4% of new funds for Federal Extension.
(4) distribute the remainder as follows:

-- 20% in equal portions (no change).
-- 15% on cash farm receipts (new element).
-- 45% on farm population (now 40%)
-- 10% on total population (now 40% for rural population).
-- 10% for special project grants to one or more states (new element).

The new cash farm receipts factor would emphasize the Extension role in commercial agriculture. The revised formula would also legitimize a wider clientele by replacing rural population with total population. State innovation and cooperation would be encouraged by the new special projects funding.

Some states would gain or lose substantial funding over time. Major winners are California (+ 58%), Nebraska (+ 39%), Iowa (+ 34%), Kansas (+ 30%), and North Dakota (+ 27%). Big losers are West Virginia (- 44%), Puerto Rico (- 32%), Pennsylvania (- 31%), South Carolina (- 31%), and New Hampshire (- 26%). There are more winners (29) than losers (26). Southern states are large losers, except for Florida, Texas, and Arkansas. The attached Table 1 shows the outcome nationwide.

As a fallback, the Task Force proposed an alternative formula that keeps new elements but also reinstates the traditional factor of rural population. This alternative would reduce the magnitude of the changes, although California would still increase by 58%. Big winners are California, Arizona (+ 28%), Florida (+ 23%), Colorado (+ 21%), and New Jersey (+ 18%). Big losers are Kentucky (- 16%), West Virginia (- 16%), Tennessee (- 14%), Puerto Rico (- 13%), and North Carolina (- 11%). Except for Florida and Texas, the South still loses, although by much less than in the other formula. Table 2 shows the nationwide outcome.

The Southern states might fare better if a means tested factor were included, such as families below poverty level. The current farm population factor does focus extension on the total farm population, including limited resource farmers, more than the proposed cash farm receipts factor. One could argue that large commercial farmers can be served primarily by the private sector.

Even if there is no consensus for a major change in the formula, a good case can be made for a special projects factor. Regional research funds have been 25% of the Hatch formula since 1946. They stimulate state cooperation on regional or national research problems, which reduces duplication. As resources tighten, Extension needs a similar mechanism for encouraging state cooperation. Unlike the Hatch Regional Research projects, Federal staff should be represented on the Extension special projects selection committee to strengthen the USDA national leadership role.

The Extension in the Eighties report stressed the need for a very broad, locally determined mission with a special emphasis on agriculture. This broad mission would seem to justify introducing new elements into the formula for cash farm receipts and total population. If the funds were growing in real terms, there might be a greater consensus for a formula change. But the Smith-Lever 3(b+c) formula has declined by one-fifth in real dollars over the past decade. This trend largely contributed to the decline in Federal funding from 39% to 34% of total Extension funds. A formula change might distribute this shrinking pot more equitably, but it will not by itself convince the Administration or Congress to increase funding. The Extension system may begin placing higher priority on earmarked increase requests. This may be the only budget strategy with a chance of significant success, considering the widespread disagreement about Extension's mission and clientele.

The information on the following pages provides more background.

EXTENSION

Current and Alternative Formulas for Distribution of Smith-Lever Increases

Current Formula

... 4% for Federal Administration

Of the remainder:

... 20% equally
... 40% on rural population
... 40% on farm population

Primary ECOP Task Force Recommendation

... 4% for Federal Administation

Of the remainder:

... 20% equally
... 45% on farm population
... 15% on cash farm receipts
... 10% on total population
... 10% for special projects

Alternate ECOP Task Force Recommendation

... 4% for Federal Administration

Of the remainder:

... 20% equally
... 25% on farm population
... 15% on cash farm receipts
... 10% on total population
... 25% on rural population
... 5% for special projects

PROPOSED FORMULA DISTRIBUTIONS FOR NEW MONEY COMPARED TO CURRENT DISTRIBUTION

	PERCENTAGE CHANGE	
	Primary Formula Revision recommended by ECOP Task Force	Alternate Formula Revision Recommended by ECOP Task Force
Alabama	- 19%	- 6%
Alaska	- 7	+ 1 %
American Samoa	+ 6	+ 4
Arizona	+ 15	+ 28
Arkansas	+ 1	*
California	+ 58	+ 58
Colorado	+ 26	+ 21
Connecticut	- 23	+ 4
Delaware	+ 3	+ 5
Florida	+ 4	+ 23
Georgia	- 18	- 5
Guam	+ 1	+ 2
Hawaii	+ 15	+ 17
Idaho	+ 14	+ 2
Illinois	+ 22	+ 7
Indiana	+ 1	- 9
Iowa	+ 34	+ 3
Kansas	+ 30	+ 9
Kentucky	- 7	- 16
Louisiana	- 19	- 2
Maine	- 24	- 4
Maryland	- 9	+ 2
Massachusetts	- 23	+ 8
Michigan	- 20	- 9
Micronesia	*	*
Minnesota	+ 19	- 4
Mississippi	- 16	- 6
Missouri	+ 7	- 9
Montana	+ 12	+ 1

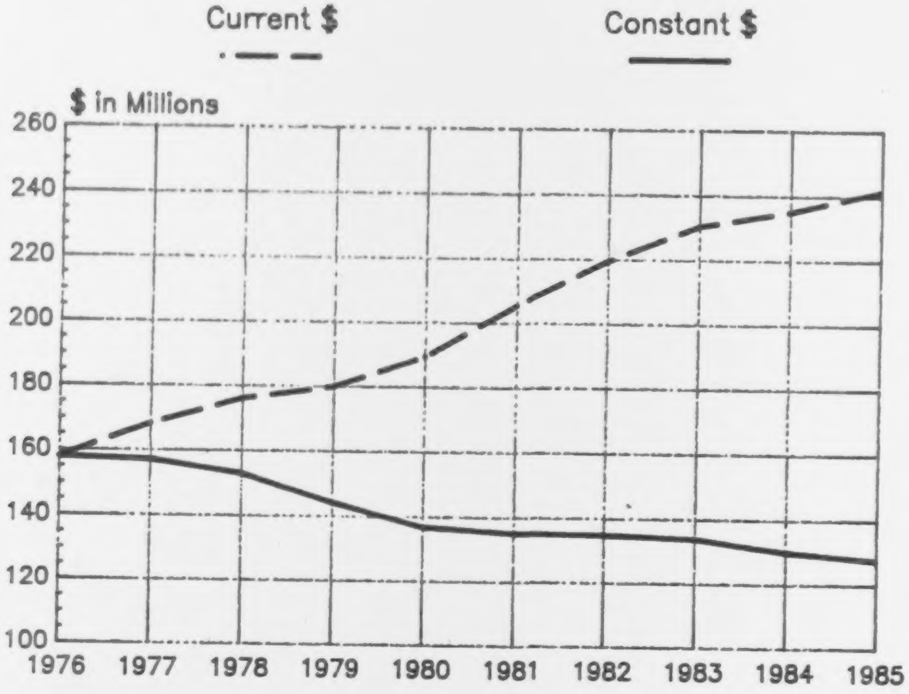
PERCENTAGE CHANGE

	Proposed Formula Revision Recommended by ECOP Task Force		Alternate Formula Revision Recommended by ECOP Task Force	
Nebraska	+ 37%		+ 11%	
Nevada	+ 8		+ 9	
New Hampshire		- 26%		- 6%
New Jersey		- 4	+ 18	
New Mexico	+ 4		+ 9	
New York		- 12	+ 7	
North Carolina		- 24		- 11
North Dakota	+ 27		+ 2	
Ohio		- 10		- 9
Oklahoma	+ 6			- 2
Oregon		- 4		- 4
Pennsylvania		- 31		- 9
Puerto Rico		- 32		- 13
Rhode Island	+ 3		+ 8	
South Carolina		- 31		- 9
South Dakota	+ 25		*	
Tennessee		- 14		- 14
Texas	+ 11		+ 11	
Utah	+ 9		+ 8	
Vermont		- 11		- 5
Virgin Islands	+ 2		+ 3	
Virginia		- 22		- 11
Washington		- 1	+ 4	
West Virginia		- 44		- 16
Wisconsin	+ 6			- 9
Wyoming	+ 9		+ 4	

* Less than ± 1%

NOTE: More detailed tables showing the effects of the proposed formula revisions are held in the Subcommittee's files.

Smith–Lever Extension Formula



COMPUTER TECHNOLOGY

I. Charter Language.

Extension has placed a very high priority on acquiring computer expertise and establishing a computer network at the county level nationwide. Packaging and transferring information on computers is the most fundamental change in educational methods since the beginning of Extension. The report called on Cooperative Extension and Research to assume responsibility for translating research into software packages accessible to all. Many states are moving rapidly to acquire computer capability, although no Federal funding has been provided for this purpose. The Kellogg Foundation has provided critical funding that encourages regional sharing.

The computer age will fundamentally transform CES staffing patterns, county program emphasis, and clientele reached by county agents. Some states are already placing greater emphasis on information wholesaling, instead of attempting to reach most target audiences directly. Shortages of computer expertise emphasize the need for regional sharing. Although the internal adjustments will vary by state, some nationwide assessment of the future role of county agents might facilitate planning.

The National Agricultural Library participates on the Extension computer technology task force. A number of joint activities are underway or planned.

Issues. What are the proper roles of CES and the private sector in computer technology? Is the private sector dependent on CES for prototype software? Will Extension be able to evaluate all commercial software? How many states now have county level computer networks? Is there a hardware compatibility problem between states or between county-level USDA offices and county extension offices? What more can be done to encourage regional sharing of limited computer expertise? What are the implications for county programs and agents? How will the Library and CES interact to improve information services?

II. Additional Background

The Extension in the Eighties report projected that by 1990 all large farms and three-fourths of all mid-sized farms would utilize computers or programmable calculators. Extension must quickly acquire computer expertise or become an obsolete educational system.

DORFA and CRS organized a hearing and workshop on Information Technology for Agricultural America in May,

1982. The computer revolution was already spinning off a bewildering variety of public and private services for rural America. There was a general consensus that the public sector should only be involved in areas where there was no profit potential. Congressman Brown emphasized that "we need to define what nobody else can do." The market has changed greatly since 1982. One Extension computer specialist estimated that Extension's computer technology expertise has doubled since then, but the private sector capacity has increased by ten-fold.

Extension has been unable to generate Federal funding support for a computer technology initiative. This is largely due to uncertainty about the Extension role, and a perception that the private sector will meet farmers' needs. But Extension is pursuing an active role despite funding limitations. A recent USDA publication, Computers on the Farm, refers farmers to county and state Extension specialists to evaluate private software and offer guidance on hardware and software purchases. The ability of Extension agents to offer consistent evaluations of all commercial hardware and software is limited. Evaluating software is a difficult, time-consuming task. It will be very difficult to keep up with the proliferating software, even if one center is given this responsibility and funded adequately.

The private sector has taken the original problem-solving software developed by Extension-and farmers and repackaged it in sophisticated software with more consumer appeal. Extension has a largely unfulfilled role identifying new technology breakthroughs and ensuring they are incorporated in private sector software. The North Central Computer Institute is funding some multi-state, multi-disciplinary projects to develop advanced software in certain problem areas. Documentation for this software will be made available to the private sector.

Extension and private firms are both developing videotex systems that can send market information and analysis, weather and pest advisories, etc., over the telephone to a farmer's microcomputer or TV. A county-based Extension videotex network can offer low user phone costs, non-profit fee schedules, and localized weather, cash market and community information. The leading Extension videotex system is in Maryland, which is offering its ESTEL system on the Eastern Shore. The participation fee is $40 per year. Fifty farmers now subscribe. The system offers weather for 9 Maryland zones, and a special agricultural weather advisory on spraying and drying conditions during the growing season. This summer, integrated pest management advisories will be offered based on local soil and weather data provided by volunteers via touch tone phones to the National Weather Service. Local agents can add pest advisories or educational material. The private GRASSROOTS videotex system is also targeting the Eastern Shore of Maryland, Delaware and Pennsylvania this summer. The cost will be about $650 per year, including phone calls. The high resolution graphics and text can be shown on a personal computer with a color monitor, or on a TV using a decoder. GRASSROOTS will have a large mainframe computer with much greater capability to access worldwide information systems than ESTEL. It uses a unique gateway system to determine users' needs and hook them up to other computers. For example, a farmer accessing GRASSROOTS could be hooked up to the Chicago Board of Trade computer for live market reports, or the Sears catalogue. GRASSROOTS will also offer localized weather and carry Extension information. Two-thirds of GRASSROOTS revenue will come from advertising. GRASSROOTS subscribers could also join the ESTEL system. ESTEL and GRASSROOTS may largely serve different clientele. Officials from each system insist that they are not competing.

Federal leadership is largely through special projects funding. For example, USDA supported the development of an on-line catalogue of all Extension-developed software (about 1500 programs). This will facilitate sharing among states and improve private sector awareness of Extension software. USDA also supported the Green Thumb project in Kentucky, which showed the feasibility of an Extension videotex system. The National Agricultural Library (NAL) is now cooperating more with Extension to enhance information services. The Library's Director, Joseph Howard, participates actively on the ECOP Computer Task Force. NAL has a project to put the frequently revised Pork Industry Handbook, developed by USDA and State Extension, on-line as a complete text, accessible anywhere in the U.S. NAL is collecting all Extension publications (estimated at 75,000) and developing an on-line catalogue.

It is still unclear what the role of Extension will be in software development and operating videotex systems. The Extension role will vary by state depending on local needs and State Extension expertise. There will be a period of overlap among states and with the private sector. Funding constraints will prevent most states from staying on the leading edge of the technology. In the long run, the role of the county agent will change as people learn to access regional and national information sources. The county agent may concentrate on providing specialized local information and reaching non-computerized clientele.

The information on the following pages provides more background on this complex area.

SYSTEMS ANALYSIS - COMPUTER TECHNOLOGY

Summary: Needs Assessment for the Food and Agricultural Sciences

Joint Council January 1984 (excerpts)

With increasing reliance on large-scale operations, optimization and yield forecasting are becoming important features of agriculture. Since computers are within reach of individual farmers, modeling concepts can provide important means for increasing the efficiency of resource use in crop production. Science and education must provide more information and computer programs that can forecast for specific crop systems the benefit of various inputs in terms of yield, income, capital requirements, tax consequences, etc. There is a tremendous need for improving the usefulness of these tools.

Computers on the Farm

Farm Uses for Computers, How to Select Software and Hardware, and Online Information Sources in Agriculture

United States
Department of
Agriculture

Farmers'
Bulletin
Number 2277

March 1984 (Excerpts)

Information Available From Your County Extension Agent

State Cooperative Extension Services are helping States provide computers for county offices. Many State Extension Services already have computers in nearly every county Extension office.

If you are considering buying or leasing a computer system, or want software or timesharing services to make the most of the system you have, a good place to go is to your State or county Extension office. In many States, county Extension offices have terminals connecting them to mainframe computers; some have microcomputers which give them access to information on crop management, animal production, and marketing.

The county Extension staff can tell you what is available online in your area that is tailored to your kind of farming and your region. The Extension staff will also be able to tell you the software programs applicable in your State. Many State Extension offices have publications on computers, and others have or are developing online information networks linking farmers and other users to the State university mainframe computer and its data base.

State Extension specialists are a logical place to start when looking for software that is appropriate to your needs. Many State Extension computer and agricultural experts have produced software materials that are available, and the county agent will know about them.

In some cases the county Extension office can lend you software. If you don't have a computer, the Extension office may be able to run programs for you, choosing the appropriate software available and plugging in the precise conditions and problems on your farming or ranching operation. Or they may be able to use the computer to search for informaton you need, perhaps communicating with a large State, regional, or national data base.

As lower cost computers with improved software have become available, an increasing number of people are turning to their State Cooperative Extension Services for training in computer fundamentals, equipment selection, and software evaluation. County agents can help people find what is available, but they probably will not be preparing software programs themselves.

Where to Look for Good Software

Where do you find good software? Some farmers and ranchers write their own programs or pay a programmer to write a custom program. But most get existing programs either from State Extension sources or from commercial outlets.

Many operations farmers need to perform on a computer can be done by using generalized software packages readily available through commercial sources.

Check with your County Extension Agent. He or she may know of the programs that have been tailored for your operation. The Extension Service has published a directory of agricultural software programs produced by State Extension Services, entitled "Updated Inventory of Agricultural Computer Programs."*

There are also various private directories of software that is compatible for particular equipment. You can get these programs at computer stores or through mail-order sources. Many trade journals carry ads of agricultural software vendors.

The land-grant university in your State may have computer programs available for farmers at nominal cost. Many States have produced extensive computer software. There are also many commercial software houses that produce computer programs in the field of agriculture. The best programs are written by people who combine strong expertise in the agricultural subject matter with the ability to write good computer programs that are relatively "friendly" or easy to use.

The 1980's have seen a big jump in the number, quality, and friendliness of agricultural software. But you still need to evaluate carefully the programs you are considering. Remember that software selection and evaluation are important factors to consider when planning a computer system for your farm.

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*To order a copy, send $3.50, payable to the University of Florida, to
Administrative Services
Institute of Food and Agricultural Sciences (IFAS) Bldg. 664
University of Florida
Gainesville, FL

It's useful to have software evaluated by a reputable source—for example your local county Extension agent, State Extension specialist, or a neighbor who has had experience.

"Let the buyer beware" is a good motto to remember as you shop around for a computer system.

Historical Sources of U.S. Agricultural Productivity: Implications for R&D Policy and Social Science Research

Amer. J. Agr. Econ.
December 1983

James T. Bonnen

Excerpts

. . . The information revolution involves computer and communication technologies that are changing society in fundamental ways, agriculture included. The colleges are experimenting with computer networks that provide access to information plus problem-solving software for various farm decisions. Four satellite-linked proprietary market information systems are now in place. Many farmers already have the microcomputer capacity for receiving and processing such information. Ultimately, it should be possible for a farmer to sit at his computer and do most of the analysis for total farm system planning and decision making.

Once well-developed proprietary information systems are in place, they will inevitably add to their capability the biological and economic behavior models on which the experiment stations are now working. As these models develop analytical and decision power, they are likely to become a vehicle for utilization of future research important in farmers' production and marketing decisions.

. . . Within the decade these information processing and communication technologies and the institutional forms for their control will be mature. Whoever controls the dissemination of the farm decision models is likely to control the dissemination of future research knowledge and the analytical capacity needed for farmer decisions. They will also dominate the further development of the models.

The social implications of these technologies are large but uncertain. The potential combination of communication and processing technologies seem endless and are being explored in investment gambles and market wars. The implications for public research and extension range from being captured to being frozen out by proprietary firms combining communications with farm input or output marketing functions. Most likely there will be a vital but different public institutional role, especially in its relationship to the private sector.

THE COMPUTER - Management Power for Modern Agriculture

Extension Committee on Operations and Policy July 1982 (excerpts)

Organizing for Extension's Role

The fundamental objective of the computer based information delivery system is to enhance or improve the basic function of Extension by utilizing the unique capabilities of the computer. This is a new and significant delivery mechanism, supplementing some existing systems and ultimately substituting for others. Some of the major functions unique to the computer are:

a. In information communication and data collection, where speed and currency are important, including graphic presentations with or without animation;
b. Memory applications in which large quantities of repetitive material are used, such as mailing lists, program enrollments, and instances where regular, periodic, minor updating of technical publications is necessary;
c. Speed and accuracy in problem solving applications and analysis of decision alternatives for individual clients, using their own data;
d. Instructional aids to extend limited specialty resources to field staff, individual clientele and groups;
e. A means of integrating the input of several discipline specialties in dealing with a complex problem; and
f. Bibliographic and other data base information retrieval applications.

Administrative and Technical Staffing

Each Extension Service currently has one or more variously named service departments—e.g., Ag Information, Ag Communications, Office of Conferences, Office of Short Courses, etc. With current computer technology, a new dimension or department should be added to the service and delivery structure of Cooperative Extension. For lack of a more precise description, we call this the Extension Data Department. This department would provide administrative and technical support for the adoption of computer technology by:

- Providing improved communication between subject matter specialists and the county staffs;
- Establishing standards for computer programs, data base structures and inter-computer communications protocols to assure compatibility across the college;
- Promoting the effective use of computers;
- Representing this area of interest in college administration; and
- Organizing and conducting in-service training.

The cost of adding a quality computerized information delivery system is significantly high. The organizational and cost structure of an example system (Purdue FACTS) is presented in Appendix B. While total cost levels would doubtless vary between states, the major cost items include:

a. Salaries for new administrative and technical personnel (the Extension Data Department);
b. Fringe benefits and overhead;
c. Equipment amortization, maintenance and operating costs.

As a general guideline, the initial equipment outlay for a county Extension office installation would approximate the following:

Microcomputer (multi-user capability)	$5,000
Dual purpose printer (letter/draft)	2,000
Hard disk	3,000
2 CRT terminals	1,500
Modem	250
Vendor supplied software	750
Total	$12,500

In addition to the county-level equipment, there is a need for a communications network, equipment for state specialist use in academic departments, a "front end processor," and general operating costs. New professional staff will be needed to operate this system. We estimate one such support person for each six counties as a general guide. Recognizing the state-to-state variations in how these services would be provided, their costs cannot be specified with precision. However, a reasonable estimate of annual costs, expressed on a per county basis, is developed as follows:

County equipment amortization (20% of cost)	$2,500
County equipment maintenance and operation (18% of cost)	2,250
Central support personnel salaries	4,167
Central support personnel fringe benefits and overhead	2,083
Central equipment, communications and operating costs	4,000
Total	$15,000

On a national basis (3,600 counties), the total annual cost is $54 million including $25 million in annual salary support for the 600 technical personnel to be employed.

This allows for no new educational staff to work with clientele. This allows for no additional academic specialists to guide software development—only technical personnel to assist existing staff develop software programs.

In summary, adding such a new delivery system to the typical Cooperative Extension Service can involve devoting five percent of the total budget to this dimension alone. This can be provided by (1) adding new resources if they can be found; (2) diverting existing resources which is difficult when of such magnitude; or (3) a combination of new and existing resources—the normal route for a major new program delivery system.

THE COMPUTER - Management Power for Modern Agriculture

Extension Committee on Operations and Policy   July 1982 (excerpts)

Private and Public Responsibility in Software Development

The private and public sectors have cooperated in the development of relevant software. The general categories of software development can be summarized in the following categories as identified in the previous section.

I. **Technical Farm and Ranch Automation**
These programs will be primarily developed by the research and development department of individual companies and sold with their products. Some of the more complex work may be done by university scientists on contract, but the bulk of this effort will remain in the private sector.

II. **Record Keeping**
This application area will be significant in determining the acceptance and purchase of computers on the farm. Here is where the computer will become a day to day part of the farming operation. Although the configurations for many of these records will come from Land Grand specialists and scientists, the final programs, languages and software packages for different computer makes will be designed by the private sector. This movement is gaining momentum rapidly. The quantity and quality of software available for most equipment leave much room for progress in this area.

III. **Communications and Data Base Access**
This area will need to be a cooperative effort of the public and private sector. The public sector will develop the data bases and make them accessible. Likewise, the public sector will provide much of the weather, market and other pertinent, timely information needed for daily farm production and marketing decisions. The private sector will provide the bulk of the access to this information as their networking systems are developed and made available on a commercial basis. If private networks are not available, public capacity for such networks may be maintained until the private sector establishes its own means for dissemination.

IV. **Decision Aid Programs**
The computer can be the significant agricultural innovation of the 1980s only if the management program software can be developed for the computer and made available on the farm. Only then can we look to the possibility of an era of *management power* on the farm by the 1990s. Clearly this sector is in the public domain—Land Grant universities and USDA—from which the knowledge base of scientific American agriculture now emanates. Through copyrights and franchises of one kind or another the private sector, in cooperation with the public sector, will market these programs.

V. **Office Management**
Development of this applications area will be the result of efforts in both the private and public sectors. Computer software for text processing, mailing lists and generalized data base management systems is available from the private sector. Those applications, such as county fair premium listings, judging contests, program planning and reporting will necessarily be developed within the Cooperative Extension Service (public service).

Software Policy Issues

The extension, research and teaching components of our Land Grant universities are discussing software policy issues in depth at the present time. "Administrative Policies for Computer Information Systems" has been developed and agreed to in principle by the North Central Directors of Extension and Experiment Stations in March, 1982 (see Appendix C).

Issues relevant to this area of software programming included in the document are as follows:

1. "Increased faculty efforts in applied research, design, development, field testing, applications and evaluation of computer software components are encouraged and supported by administrators of research, extension and resident instruction in universities of the North Central Region.

ADVANTAGE

Control Data's Agricultural Community Services
(Excerpts from Nov. 1983 promotional material)

ADVANTAGE
...a new concept to help the family farm

Your ADVANTAGE dealer represents a new concept in bringing education and information to the agricultural community.

The ADVANTAGE services can help you right now — without a substantial initial investment of your time and money.

Through your ADVANTAGE dealer you can take full advantage of current computer services.

And you can do it on your own time, at your own pace, paying only for what you need.

What about the rest of the community?

As ADVANTAGE services grow and develop, your local dealer will continue to open new doors and make available new tools to you and your family.

Although your ADVANTAGE dealer is offering only agricultural services now, Control Data and your dealer are committed to being a broad-based rural community resource.

So, as the ADVANTAGE program grows and develops, services benefitting your entire community will be added, many of them available to the owners of home computers.

* * *

ADVANTAGE: Control Data's Agricultural Community Services

Gathering, storing and disseminating knowledge essential to agricultural success, Control Data works with experts all over the world to expand its agricultural services. Priority is given to techniques consistent with high production per acre, low capital investment and decreased consumption of fossil fuels.

Why? Because Control Data is committed to meeting the information and knowledge needs of farmers like you in an affordable and accessible way.

* * *

Two types of services are being offered by your ADVANTAGE dealer: computer-based education programs and computer-based production aids. A third computerized service — an agricultural data base — will be available soon.

There's even a financial recordkeeping service where the books keep up with you

Keeping track of where the money goes is often a long, frustrating, come-from-behind job.

But with the new AgCHEK™ service, you don't have to keep up with the books. The books keep up with you.

Using specially designed check blanks, you simply identify the type of expense by circling the proper expense categories on the pre-printed check. After the check clears your bank, it's entered into the computer at your ADVANTAGE dealership.

The computer takes over from there. You receive a complete report monthly of your financial situation that tells you how much you spent (this month and year-to-date) in each key area of your operation and family budget.

The same system works to record your income flow — the price received when you market your crops and/or livestock. With good, more timely information from AgCHEK, you can do a more effective job of making management decisions, preparing credit documentation and planning for taxes. The range of available check formats has been tailored to your needs.

And a variety of information and data base services are being planned to help you even more

Whether you're curious about something you've seen in your fields or need information about treating scours, ADVANTAGE services currently being field-tested will soon be able to help. There's no tool quicker than the computer, and all of the agricultural information in the Control Data AgTECH® data base will soon be at your service.

The AgTECH data base would be the first service available in a comprehensive information and data base package called AgFACTS®. It will contain thousands of pages of information prepared by the world's leading agricultural experts about such subjects as dairy cattle forage, fertilization requirements for crops, swine herd improvement, and so on.

* * *

Control Data's PLATO computer-based education programs have been used successfully to train people in many fields: airline pilots, medical personnel, sales people and others. The growing library of agricultural education programs being delivered through your ADVANTAGE dealer has been developed by farmers and leading agricultural authorities and prepared through cooperative efforts with universities and other organizations.

AGRISOURCE

PURPOSE: The USDA Extension Service has developed a concept known as AGRISOURCE which is a solution to some of the problems created by the current explosive growth of information technology. It is estimated that there are currently more than 1,700 computerized data bases available for public use. Each of these data bases is accessible on its own computer host using that system's protocol and access language. Research has shown that it is impossible for most users to be literate in more than six or seven different access languages and protocols. The problem is obvious, something must be done to simplify access to these rapidly proliferating electronic information resources. AGRISOURCE is an interface between the users and the information resources. It would, through a user friendly dialog, determine what the users' information needs are in terms of subject matter and kind of information and advise the user of the information resources which are available. When the user has made a choice, AGRISOURCE would make direct contact with the host computer containing the information resource, rephrase the user's query into the language required by the host computer and retrieve the information for the user. The user would need to know only the protocol and access language required by AGRISOURCE.

The concept has been developed on a limited basis for the Environmental Protection Agency in a system called Chemical Substances Information Network (CSIN). CSIN provides a single access protocol and search language for several data bases dealing with the properties of chemical substances. It has been tested and proved effective over a period of four to five years. The technology that supports CSIN might be the starting place for the development of AGRISOURCE.

SCOPE: The AGRISOURCE concept could be applied throughout USDA. It could be useful to members of the agricultural community everywhere. Its development ought to be not only Department-wide but carried out jointly with members of the private sector.

TECHNICAL CONSIDERATIONS: The AGRISOURCE interface would be a hardware/software link between the user and other computer supported data bases. The CSIN link has been developed by Computer Corporation of America. There are other similar efforts taking place in the private sector at this time. The technological problems are not the only ones to solve. Data base vendors may be reluctant to provide access to copyrighted material through the services of another vendor. New kinds of arrangements must be made for billing and servicing these kinds of accounts.

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NOTE: The private GRASSROOTS system is based on this type of gateway technology.

CATALOGING AND SHARING EXTENSION COMPUTER PROGRAMS

The State Extension Services make use of many computer programs in their educational programs, both for management of those programs and as teaching resources. For many years, the Extension Service has periodically compiled a publication describing computer programs currently in use. The most recent of these publications was produced last year by the University of Florida and contained descriptions of over 1,500 different computer programs. With the advent of microcomputers there has been a rapid proliferation of computer programs and there is a need to make information about them readily available so that states may take advantage of each others development work and share these products rather than create new versions of programs already in existence. An on-line index to available computer programs will be developed jointly by the states of Florida and Virginia using the resources which went into this most recent publication and including updated information about new programs which were not included in that publication. The computer Management Network at Virginia Tech University will provide for on-line storage of the information about the programs. This will provide the capability to search for computer programs by subject, computer type or program language and find existing programs which may be useful and the source from which they may be secured. Additional work is being done experimentally in South Carolina and Colorado to determine whether it is feasible to store entire programs on-line and down load them from a central computer to a micro computer where they can be run without needing to continue to be in contact with the central computer.

These efforts to compile unclassified programs are a first step in several which will enable the Extension Service to share its computer program resources. The North Central Computer Institute at the University of Wisconsin is currently involved in the development of standards for programming language, conventions and documentation which will improve the transferability of programs used by the Extension Service. The development and adherence to these standards will make it relatively easy to transfer programs from one state to another and from one brand of micro computer to another.

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EXTENSION SERVICE COMPUTER NETWORKS

PURPOSE: Within the Extension Service the effort to make computer technology more accessible to state and county workers has been expressed in several initiatives. These initiatives have resulted in the development and continuing operation of several computer networks. Some of these include AGNET, operated by the University of Nebraska, Computer Management Network (CMN) operated by Virginia Tech, TELPLAN operated by Michigan State University, FACTS, operated by Purdue University and the Minnesota Educational Computing Consortium (MECC) of which the Extension Service at the University of Minnesota is a member. These networks operate primarily for the purpose of providing computer programs which are used in Extension's educational programs. Programs related to the operation of an agricultural enterprise predominate, but these networks also provide programs which are used in Home Economics, and 4-H Youth educational activities. AGNET, CMN, and TELPLAN, are networks which provide access to a central computer on which many programs are stored. MECC provides access to a variety of computer resources and FACTS provides a network of programmable terminals, one in each Indiana County Extension office, which have stand-alone processing capability as well as access to a large central computer. Michigan State University has linked TELPLAN and other computer resources into a user friendly accessible network of services called COMNET.

SCOPE: CMN and AGNET have the potential to be available to all states. Although they were developed originally for use by Extension Service and other University users, they are used by farmers and agribusiness people as well. FACTS and TELPLAN are primarily in-state networks used by the Extension Service within Indiana and Michigan and MECC is a network used by several educational organizations in Minnesota.

TECHNICAL DESCRIPTION: These networks use a variety of central computers accessible through telephone linkage to local dialup terminals. They may be accessible by dumb terminals, programmable terminals, microcomputers, or remote job entry devices. The FACTS network uses a specific brand of programmable terminal in the county Extension office which has the capability to run small programs locally or to dialup to the main frame computer on the Purdue University Campus to access large programs or large data bases.

The rapid growth of the microcomputer has presented new challenges to the managers of these networks. Efforts are under way to develop the capability to store microcomputer programs on a large main frame computer. They can be transferred to a microcomputer with communications capability which then will sever the communications link and run the program as a stand alone device. This process of downloading has the potential for providing linkages between networks. For example a single access point in a state could retrieve information from a main frame computer in a national network, store it, then download that information to county microcomputers for further processing or utilization.

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Farm Management, Agricultural Programs
Extension Service, USDA
Room 5505-South Bldg., Washington DC 20250
202-447-7165

REGIONAL COMPUTER INSTITUTES

PURPOSE: The Cooperative Extension Service offices are taking the lead to work with Experiment Station Directors and University Administrators in the establishment of Regional Computer Institutes. The purpose of these Institutes is to provide a center for education, research, exploration and coordination of activities related to the use of computers in educational and research programs. There will be provisions for seminars and workshops, as well as for short term assignments to the Institutes. By acting as a focal point for the region, the centers will also gather and disseminate information about the state of the art in computer applications.

SCOPE: The North Central Computer Institute has been in operation at the University of Wisconsin for more than a year. The center has numerous projects under way including one to develop standards for documentation and programming languages, especially for microcomputer programs, in order to improve the portability of these programs. Dr. John Schmidt is the Director of the North Central Computer Institute.

The Northeastern region is currently conducting a feasibilty study to determine how a computer institute would operate in the Northeast region, what functions it should perform, and how best to establish it. The Southern region is conducting an exploratory meeting later this winter with representatives from ECOP, ESCOP and RICOP to make similar determinations for the Southern region. An active committee for the Western region has held its first meeting to discuss a Western Regional Computer Institute and is currently beginning exploratory activities for that region.

TECHNICAL DESCRIPTION: Implicit in the development of these Regional Computer Institutes is the plan that they will work cooperatively with each other to share the results of their efforts on a national basis.

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HIGHER EDUCATION

I. Draft Charter Language

The February hearing provided an excellent overview of higher education needs. While quantity of graduates in many fields was recognized as a problem, many witnesses expressed great concern about quality.

The fellowship grants program will slowly begin to augment the supply of high quality graduates in certain disciplines. The program will attract high quality students to already strong schools. If maintained at the $5 million level, the program will only fund one group of about 300 Ph.D. graduates every three years. Although this is inadequate, valuable experience will be gained in operating this type of program.

By strengthening curricula and faculty nationwide, improvements in quality of graduates would be more widespread and high quality applicants would be attracted in greater numbers. Current efforts in this area need to be strengthened. Ways must be found to encourage greater industry participation. Strengthening grants awarded on a competitive basis may be necessary to ensure broad participation in these efforts.

The USDA 1980 supply/demand study was an important attempt to project needs in a very complex area. A fully developed Food and Agricultural Education Information System (FAEIS) would provide a more current outlook and serve as a useful national and state planning tool.

Issues. How should Title XIV be amended to encourage state or private matching of higher education grants? What more can USDA do even without special appropriations to disseminate the results of curricula and faculty development efforts? What are USDA's plans for completing and making available on-line a comprehensive FAEIS system?

II. Additional Background

Congress provided $5 million for a new competitive graduate fellowship grant program in FY 1984. This program was authorized in Title XIV in 1977. The $5 million is enough to fund approximately 300 graduate students for one year of study at about 30 institutions. USDA plans to provide a block of funds to a college with an excellent plan to develop high quality graduates. The college would then award the funds to a limited number of new students. The Ph.D. stipend is set at $15,000 annually per doctoral student. In FY 1984, USDA will only consider proposals in the projected shortage areas of biotechnology, human nutrition, agricultural engineering, and marketing. Only 10% of the funds will be reserved for Masters degrees. This will limit the participation of 1890 and non-Land Grant (AASCARR) public schools, which generally do not offer doctoral degrees.

USDA has never requested fellowship grant funding in a budget. The Administration policy is that funds should not be used to attract students to particular disciplines, since future needs are uncertain. This policy is unlikely to change. Administration resistance may keep this program from growing to a significant size.

USDA might be more successful in requesting funds for strengthening grants, which are also authorized in Title XIV. These can be awarded to schools for curriculum strengthening, faculty development, and equipment. If strengthening grants were coupled with competitive research grants, high quality students might be attracted to the improved graduate programs with research assistant stipends. The Administration position on strengthening grants is unknown.

Many witnesses at the February hearing placed primary emphasis on improving the quality of graduates by upgrading curricula and retraining faculty. Dr. King noted that Cornell has been able to select 600 Ag College freshmen out of almost 3000 applicants in recent years. This indicates that Ag Colleges with innovative, high quality programs can avoid the general trend of declining enrollment at Land Grant Colleges of Agriculture (- 22% since 1978).

USDA has convened a Curriculum Evaluation Task Force to determine critical curriculum needs. Development work on model curricula is now underway with modest funding, including industry and USDA support. Dr. King recommended that USDA strengthening grants be funded to ensure full development and dissemination of these model courses.

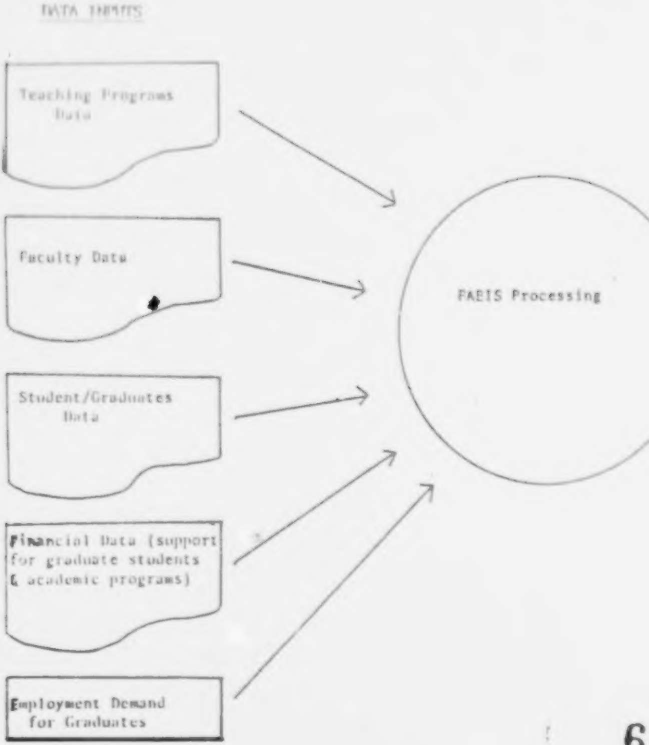
The non-Land Grant public schools (AASCARR) will not be helped much by competitive fellowship grants or competitive research grants. Although these schools graduate 40% of agricultural undergrads and one-third of the Masters, they generally do not offer doctoral degrees and lack research programs. Strengthening grants would be more accessible to them. The strength of the AASCARR institutions is critical since their graduates are frequently hired as Extension agents and Vo Ag teachers. These occupations are having trouble competing for graduates with higher degrees from more prestigious institutions, because of low salary levels.

The 1980 USDA supply/demand study only projected agricultural higher education graduate needs through 1985. It was based on mid-1970's graduate and labor force trends. The on-line FAEIS system now being developed at Texas A&M with USDA support will update these projections. It will also show projected faculty retirements by discipline and by state. For the first time, there will be a data base on research funds available to graduate students. This will make it easier to substantiate the importance of research funds for meeting national education needs. The next steps in completing the FAEIS system are: (1) obtaining data from the remaining significant Land Grant schools that have not yet responded; (2) entering personnel data from ARS, Cooperative Extension and industry; (3) projecting future demand for agricultural graduates in academia, industry, ARS and extension; and (4) developing the software needed to tie the whole system together and generate the desired reports. This is the most ambitious attempt to project supply and demand for graduates in any scientific area. Even so, the projected demand for agricultural graduates in many fields will be based on expert opinion.

The American Council on Education (ACE) recently completed a survey for NSF of plant biology faculty and students at 210 major research universities. This will be a good measure of the nation's plant biotechnology capability, both within and outside the Land Grant Colleges of Agriculture. NSF will report on the findings from this study at the hearings. It will be useful to see if the NSF study agrees that plant biotechnology disciplines are a substantial graduate shortage area.

Additional background material follows.

FAEIS OVERV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Faculty Data
Student/Graduates Data
Financial Data (support for graduate students & academic programs)
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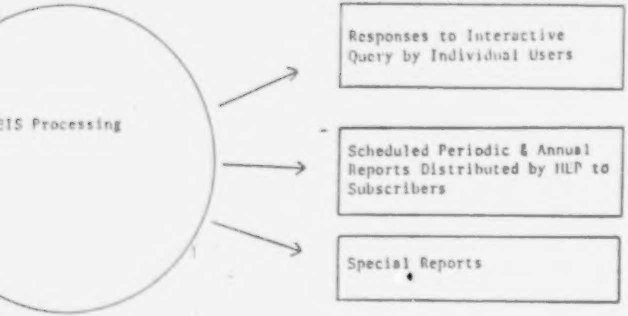

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AGRICULTURAL RESEARCH SERVICE

Long-Range Plan

I. Draft Charter Language.

ARS released its long range plan in February 1983. The planning effort was in response to widespread concern about the lack of long range planning in the system. By assuming no real funding growth, ARS was forced to accommodate change by proposing reductions in a number of ongoing programs. Some were controversial. ARS made it clear that the plan could be modified in response to public comments and changed conditions. FY 1984 management changes and FY 1985 budget requests have given ARS an opportunity to make or propose incremental changes.

Several witnesses at the hearing last June emphasized the need for ARS to acquire more economic expertise to assist in research planning and on integrated systems teams. ARS currently lacks this expertise in-house and the Economic Research Service has been unable to fill this gap.

ARS issued its Technology Transfer Plan in March. The plan lays out eight mechanisms to improve the transfer of new technology. New linkages to Extension on a nationwide computer network are included. This plan and the ongoing USDA study under contract with the Pennsylvania State University may help guide technology transfer efforts throughout the system.

Issues. Have there been major changes in the ARS plan? Is ARS able to move in new directions by exercising normal management discretion as projects are concluded or staff retire? Do the Needs Assessment findings corroborate ARS priorities? How will ARS acquire the economic expertise needed for planning and integrated systems research? What elements of the Technology Transfer Plan and findings from the ongoing USDA technology transfer study might improve the total system's efforts?

II. Additional Background

The ARS Six-Year Implementation Plan proposed major shifts in research programs, based on long range needs expressed in the ARS Program Plan and no real growth in research funding. Some of the major changes proposed were:

(1) reduce Plant Production and Protection research by 18%,

(2) increase Human Nutrition research by 50% at the expense of other research areas,

(3) increase basic research in every area at the expense of applied research,

(4) increase integrated systems research to consider a wide spectrum of interactive variables and constraints. ARS should be especially capable of organizing multidisciplinary teams,

(5) terminate most small farm, organic farming, and energy research,

(6) greatly reduce some commodity research (e.g. cotton) because of an adequate state effort or a lower national priority than other research.

Concerned parties knew that the staffing and funding shifts needed to implement the plan between 1984 and 1990 would be significant. But the plan was not detailed enough to determine exactly which locations and projects would be affected. ARS planned to announce these detailed shifts annually. Interested groups were also confused by the new research categorizations, which were first made public in the Six-Year Plan. This made the changes difficult to compare with previous bases.

Normally, about 20% ($90 million) of ARS projects are completed each year. This presents a significant opportunity for annual redirections, although existing staff expertise and community ties often make major shifts difficult. Even so, in FY 1983, prior and unrelated to the Six-Year Plan, ARS was able to redirect $17 million, mostly involving funding shifts between labs. Congress was informally consulted.

The Six-Year Plan was subsequently released in February 1983. In the FY 1984 House Appropriations Committee report, the Committee wrote that it did "not expect the Department to implement the Six-Year Plan until research results are demonstrated" and directed the Committee Investigative staff to review all ARS programs and activities.

As a result, ARS only proposed redirecting $10.7 million in FY 1984 - the first year of the Six-Year Plan. Unlike the previous year, not a single redirection involved transfer of funds between labs. ARS made the changes after informally consulting with the Congress. Most of the changes were the kind of limited redirections that ARS has traditionally made without advising the Congress.

There were shifts to more basic and integrated systems research. However, substantial shifts between major programs are not occurring at this time. For example, the FY 1985 budget did not deemphasize Plant Production and Protection research, despite the major cut proposed for this area in the Six-Year Plan. In fact ,a proportionate share of the increases went to this area (ref. attached list). The only major area without a program increase was Human Nutrition research - a high priority in the Six-Year Plan. One increase request specifically mentioned organic farming research as one part of expanded research on soil fertility.

This hesitation to rapidly implement the Six-Year Plan is understandable considering the Congressional concern. However, ARS' ability to manage research and conduct meaningful long-range planning is in jeopardy. ARS will be unable to attract the best young scientists if it has a reputation for lacking a long range mission and strong management. Proposed redirections for FY 1985, the second year of the plan, will be a good indication of ARS' ability to implement the plan.

A number of witnesses at the June research hearing last year were critical of the lack of economic analysis in ARS research planning. Several excerpts from the hearing on this subject are attached. Broad program priorities (e.g. increasing basic and decreasing applied research) must continue to be based on scientific consensus. However, economists would help direct ARS efforts at the research project level by considering potential economic return. Non-economic impacts (e.g. reduced pollution) would still have to be factored in by ARS managers.

ARS will also need economic expertise as part of the integrated systems research emphasis. To develop integrated farm systems recommendations, ARS will need to identify the interrelationships of variable production costs and estimated yields for various combinations of inputs and management techniques. The impact of new technologies would then be more apparent. These types of economic trade-offs will be more and more influential in the adoption process, because of the large scale of many farms, the costliness of mistakes, and the high cost of capital for investment in new technologies.

Dr. Terry Kinney announced in the ARS Program Plan that he would "operate ARS as a managed activity, coordinated by plan." Accordingly, ARS developed a Technology Transfer Plan (March 1984). This plan lists eight ways in which ARS will transfer research findings. Transfer mechanisms of recent vintage include:

(1) Reporting relevant ARS research findings on a special file on Extension's Accountability and Evaluation System, Extension specialists nationwide can search the file with key words to find useful new information and ARS scientific contacts for their areas of interest. The system will become interactive next year when State Extension staff can begin notifying ARS of research needs.

(2) Abstracts of research manuscripts will be sent to the ARS Office of Research and Technology Applications (ORTA) before the articles are printed. ORTA can immediately inform interested users, including Extension through the nationwide system described

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previously. Users may contact the ARS scientist for more information. This should lead to faster and more efficient dissemination of ARS research findings. The traditional channel of publishing more than 3000 journal articles each year will continue to be utilized.

These improved transfer mechanisms might be equally useful for state researchers. Ultimately, state and Federal research abstracts could go on a special data base for on-line access by other scientists or interested users. This would be broader than the ARS research file on the Extension A&E system, which only reports on research of interest to Extension. Such an on-line system for reporting research findings might be a year faster than waiting for the research updates on the Current Research Information System (CRIS).

The Technology Transfer Study being conducted by Dr. Irwin Feller at Pennsylvania State University is still in progress. Preliminary findings will not be directly useful in resolving the issues outlined in the charter. As a result, there will not be a witness to address this study.

The following pages contain additional background material.

Economic Analysis Needs (ARS/ERS)

Dr. Vernon Ruttan (Univ. of Minnesota)
Dr. Theodore Hullar (Cornell Univ.)

Research Hearings June 28, 1983 (excerpts)

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Dr. Ruttan:

mentioned as an area of collaboration at the Williamsburg Summit where other areas of science were discussed.

Eighth, I'm disturbed by the decline of economic research capacity at the U.S. Department of Agriculture. The analytical capacity of the Agricultural Research Service has been eroding since the mid-1960's. If this erosion is not reversed, the Secretary will lose his capacity for program design and analysis.

The Agriculture Research Service is one of the few major agricultural research services to have no economic or other social science capacity, no capacity for in-house technology assessment as a tool in research planning, and the ERS has no capacity to service ARS.

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Mr. Volkmer. Mr. Chairman, I'm sorry. I wasn't able to be here for the full hearing and all the testimony, but what I would maybe like to ask if there's any way that they can see that we in the Congress can improve in any way the relationship between the Federal level and you on the State level in the research program. Anyone?

Mr. Hullar. I think one thing that could be done, particularly at this moment in time, is to encourage and possibly do something even more firmer than that, encourage the ARS and the ERS to collaborate and cooperate far more than they're presently doing.

Dr. Ruttan commented about there being no economists at ARS. That's true. I think they're now in the process of hiring their first one, yet they're proposing an objective 6, and their 6-year plan is a systems analysis, an increase of $10 million. I guess that's to be economics. Where are they going to get that? My sense is that the only way to get that fast, to do what they want to do, and to capture some additional diverse brainpower besides, is to significantly increase their cooperative agreements with certain universities to capture that.

The same thing would be true with ERS. So I think there's a real possibility there. It would also help open up that system. It's advancing in age, people aren't moving into it, it's been mentioned. They may want to have sabbatics, retraining and so on. There's some real opportunities there.

That could come from the assistant secretary.

Mr. Brown. Thank you very much. Yes, Dr. Ruttan?

Mr. Ruttan. I think those are both good points, and progress can be made along that line. My own experience, however, working at the international institutes—I've worked at International Rice Research Institute during its early years—is you can't collaborate unless you have some capacity, and it's going to take some capacity, some economics capacity, within ARS working at the level, say, of the Meat Animal Research Laboratory, the individual laboratories, where you develop that—where the economist develops sufficient knowledge of the technology, and it's going to require some careful thought about how you create viable economic units, so that you don't just put the people out there and let them stagnate.

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With that, if you begin to have that, then you will be able to get more effective collaboration from ERS or from the universities. ERS itself simply doesn't have the manpower any more.

Mr. Hullar. And what they have they're taking back.

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Dr. William Marshall   Users Advisory Board
Research Hearings   June 29, 1983 (excerpts)

Mr. **Marshall**. Let's call it fundamental and maybe not get into trouble.

Mr. **Roberts**. I admire the way your fish gets off the hook. I have no further questions, Mr. Chairman.

Mr. **Brown**. Thank you very much, Mr. Roberts. Your questions have been excellent.

Dr. Marshall, you and Mr. Hatch have both commented on the need for improved analysis of marketing and trade barrier types of problems I guess the two are closely related. We have had previous testimony that indicates that in the Agricultural Research Service there is some weakness in the economic analysis, marketing analysis and, of course, this is of fundamental importance to maintaining a profitable agency.

Would it be your view that we ought to give a higher priority to this kind of effort than we have been doing, recognizing that it poses some political problems in itself when you get involved in that kind of analysis?

Mr. **Marshall**. Yes, sir, I would. I think there are several things that can be done. One is that the Users Advisory Board recommended that some personnel be temporarily transferred from the Agricultural Research Service and vice versa so that we could get two heads looking at the problem of production and export. This, we felt, would help the ERS make better projections.

I think that, second, the concept of moving the ERS people back into Washington from the field, if I understand that proposal, strikes us as perhaps a move in the wrong direction, and rather than increase the staff of people here in Washington to handle these problems, they are better, I think they can do a better job out in the field when they are closer to the problems.

For example, we have been attempting to get data, which in industry we call sensitivity analysis, on the production of agriculture to find—Congress requests yearly that the cost for the production of each major crop be identified, and there is something like 10 variables costs and a total of maybe 15 costs within each economic crop on a bushel basis.

What has not been done is determine the sensitivity of all those variable costs with the cost of production. If fertilizer costs go up, the incremental gain on yield from a financial standpoint must be less than what it was before.

To the best of my knowledge, we don't have that kind of data, and I think with the growth of minicomputers, particularly in the hands of farmers, that a farmer could have some flexibility in how he wants to manage each year. If he wants to look at 15-year weather data and make certain assumptions and say "This year I am not going to go for maximum yield, I am going to go for maximum profits and reduce yield by a little bit, assuming that the weather will be kind to me," he should be allowed that flexibility, whereas now I believe the situation is they simply push for maximum yield under the best weather conditions.

So I think in those three areas, the export, and the manpower in the field, and helping the farmer manage from a flexible standpoint his operation, I think are three areas that need to be pushed in economics.

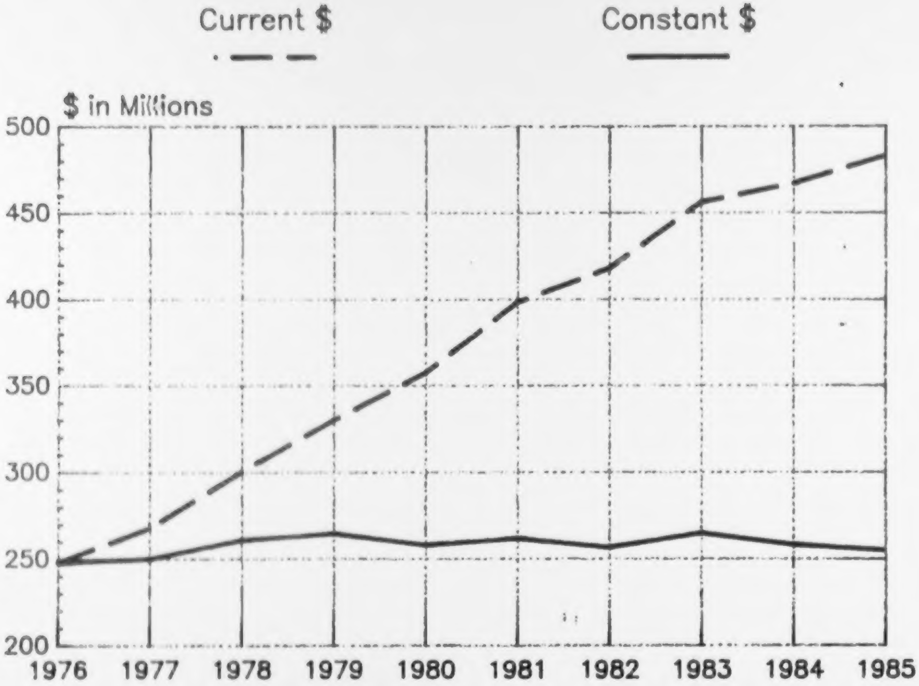
ARS FY 1985 BUDGET CHANGES

SUMMARY OF INCREASES AND DECREASES
(On basis of appropriation)

Items of Change	1984 Estimated	Program Changes	1985 Estimated
Determine genetic variation in biochemical, physiological, and behavioral traits of animals......	$ 600,000	+$400,000	$1,000,000
Methods for diagnosing livestock diseases in support of action programs.........................	600,000	+200,000	800,000
Improve genetic resistance of animals to diseases and parasites.	- -	+400,000	400,000
Interdisciplinary experiments on integrated agricultural systems...	1,900,000	+600,000	2,500,000
Genetic engineering for modifying germplasm of plants...............	2,840,000	+600,000	3,440,000
Plant protection research in support of APHIS quarantine programs......	9,624,000	+600,000	10,224,000
Research on beneficial insects......	3,171,000	+400,000	3,571,000
Methods for maintaining and improving soil fertility..........	9,758,000	+550,000	10,308,000
Research on soil erosion in support of SCS...........................	3,108,000	+450,000	3,558,000
Identify the biological and biochemical mechanisms that affect properties of agricultural materials.........................	4,000,000	+900,000	4,900,000
Research to control postharvest losses and product quality to enhance exports..................	2,906,000	+800,000	3,706,000
Higher education - 1890 Colleges and Tuskegee Education grants.....	- -	+2,000,000	2,000,000
Higher education - Morrill-Nelson (Permanent Appropriation).........	2,800,000	-2,800,000	- -
Higher education fellowship grants..	5,000,000	-5,000,000	- -
All other..........................	428,451,400	+8,181,600a/	436,633,000
Total Available....................	474,758,400	+8,281,600	483,040,000

a/ Proposed increase of $9,057,600 for annualized and absorbed pay increases effective in FY 1984, but which are necessary to carry out the programs proposed for FY 1985; and a decrease of $876,000 for improved efficiencies in administrative support activities and a phased reduction of positions in grades GS/GM 11-15.

ARS Research



6-Year Implementation Plan, 1984-1990

(Excerpts)

United States Department of Agriculture
Agricultural Research Service
February 1983

Before decisions were made on the reallocation of funds among objectives of the ARS program, the following factors were considered:

- Production by U.S. agriculture exceeds current domestic needs.
- The United States is facing an indefinite period of surpluses of major agricultural commodities.
- U.S. agricultural products are losing competitiveness in world markets.
- New products are needed for American farm commodities to more successfully compete in world markets.
- Lower production costs are needed for American farm products.
- The U.S. natural resource base is declining.
- Increased emphasis is needed on basic science in agriculture to replenish the dwindling store of basic knowledge.
- More ARS emphasis is needed on fundamental and applied research to increase efficiency of production.
- Integrative systems research is needed to improve the efficiency of U.S. agriculture.
- Improved human nutrition is a national priority.

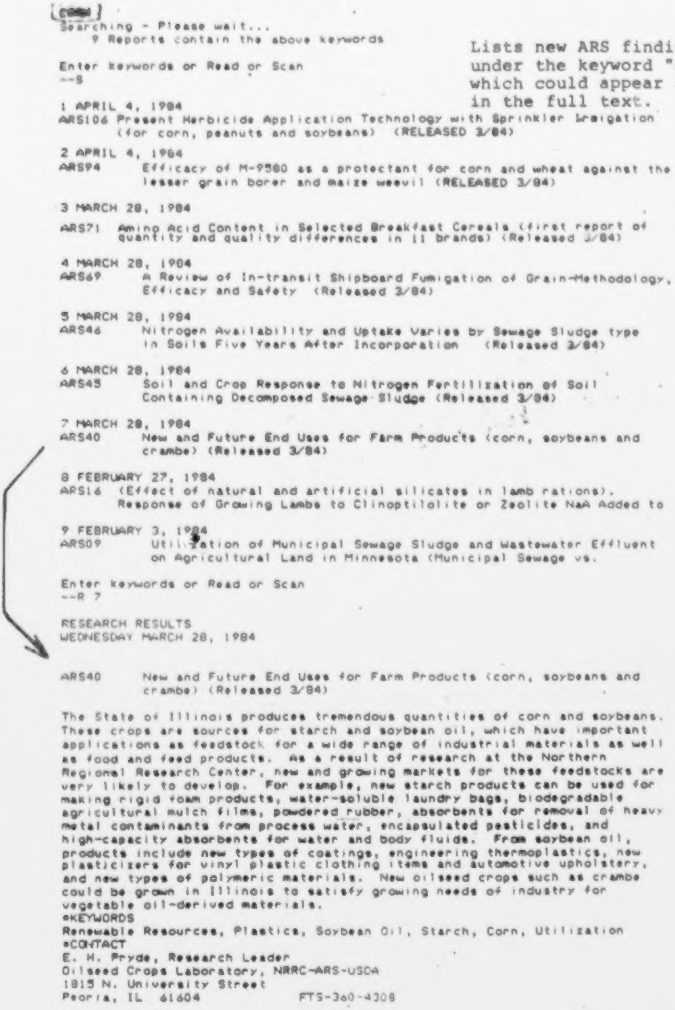
On the basis of these factors, ARS will appreciably increase its emphasis on commodity conversion and delivery and human nutrition research and modestly increase its emphasis on soil and water conservation and integrative systems research. Without increased funding, ARS must carefully reallocate funds to support essential increases at the expense of some areas of research on plant and animal production. Fundamental productivity research continues to be a national priority. However, significant portions of the conventional, applied, and developmental research components of the ARS program must be assumed by other sectors of the full agricultural research system that are capable of sharing the responsibilities for carrying out that research. Within the ARS productivity research programs that will be continued, long-term fundamental studies will be emphasized to generate the basic knowledge and technology for solving major problems in the efficiency of plant and animal production.

TABLE 1. FUND ALLOCATION STRATEGIES (INCREASES, DECREASES) FOR ACHIEVING TARGETED PROGRAM BALANCE AMONG OBJECTIVES

	Present Program Balance		Planned Program Changes ($M)			Targeted Program Balance	
Objective	$M	%	Decreases	Increases	Net	$M	%
1 Soil & Water Cons.	52	13	3	9	+ 6	58	14
2 Plant Productivity	165	40	36	7	-29	136	33
3 Animal Productivity	82	20	11	7	- 4	78	19
4 Commodity Conver.	77	18	16	26	+10	87	21
5 Adequate Human Nutri.	27	7	3	17	+14	41	10
6 Integ. of Systems	10	2	6	9	+ 3	13	3
Total	$413	100	$75	$75	$0	$413	100

Portion of <u>ARS Research Results</u> file, now available on-line to all state extension offices through the Accountability & Evaluation System.

Lists new ARS findings, under the keyword "corn", which could appear anywhere in the full text.



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1 APRIL 4, 1984
ARS106 Present Herbicide Application Technology with Sprinkler Irrigation
       (for corn, peanuts and soybeans)  (RELEASED 3/84)

2 APRIL 4, 1984
ARS94       Efficacy of M-9580 as a protectant for corn and wheat against the
            lesser grain borer and maize weevil (RELEASED 3/84)

3 MARCH 28, 1984
ARS71  Amino Acid Content in Selected Breakfast Cereals (first report of
       quantity and quality differences in 11 brands) (Released 3/84)

4 MARCH 28, 1984
ARS69       A Review of In-transit Shipboard Fumigation of Grain-Methodology,
            Efficacy and Safety  (Released 3/84)

5 MARCH 28, 1984
ARS46       Nitrogen Availability and Uptake Varies by Sewage Sludge type
            in Soils Five Years After Incorporation   (Released 3/84)

6 MARCH 28, 1984
ARS45       Soil and Crop Response to Nitrogen Fertilization of Soil
            Containing Decomposed Sewage Sludge (Released 3/84)

7 MARCH 28, 1984
ARS40       New and Future End Uses for Farm Products (corn, soybeans and
            crambe) (Released 3/84)

8 FEBRUARY 27, 1984
ARS16  (Effect of natural and artificial silicates in lamb rations).
       Response of Growing Lambs to Clinoptilolite or Zeolite NaA Added to

9 FEBRUARY 3, 1984
ARS09        Utilization of Municipal Sewage Sludge and Wastewater Effluent
             on Agricultural Land in Minnesota (Municipal Sewage vs.

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RESEARCH RESULTS
WEDNESDAY MARCH 28, 1984


ARS40       New and Future End Uses for Farm Products (corn, soybeans and
            crambe) (Released 3/84)

The State of Illinois produces tremendous quantities of corn and soybeans.
These crops are sources for starch and soybean oil, which have important
applications as feedstock for a wide range of industrial materials as well
as food and feed products.  As a result of research at the Northern
Regional Research Center, new and growing markets for these feedstocks are
very likely to develop.  For example, new starch products can be used for
making rigid foam products, water-soluble laundry bags, biodegradable
agricultural mulch films, powdered rubber, absorbents for removal of heavy
metal contaminants from process water, encapsulated pesticides, and
high-capacity absorbents for water and body fluids.  From soybean oil,
products include new types of coatings, engineering thermoplastics, new
plasticizers for vinyl plastic clothing items and automotive upholstery,
and new types of polymeric materials.  New oilseed crops such as crambe
could be grown in Illinois to satisfy growing needs of industry for
vegetable oil-derived materials.
*KEYWORDS
Renewable Resources, Plastics, Soybean Oil, Starch, Corn, Utilization
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CRITICAL ISSUES IN AGRICULTURAL RESEARCH, EXTENSION AND TEACHING PROGRAMS

Prepared for the
Subcommittee on Department Operations, Research and Foreign Agriculture
House Committee on Agriculture

A. Barry Carr, Specialist in Agricultural Policy
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Christine Matthews Rose, Analyst in Science and Technology
Science Policy Research Division

October 31, 1984

ABSTRACT

This study reviews oversight hearings on the agricultural science and education system held by the Subcommittee on Department Operations, Research, and Foreign Agriculture, House Committee on Agriculture, in 1982, 1983, and 1984. The major issues in research, extension, and teaching programs are identified and discussed.

PREFACE

In 1982 the Subcommittee on Department Operations, Research, and Foreign Agriculture of the House Committee on Agriculture began a series of oversight hearings on critical issues facing the agricultural science and education system. A major purpose of the hearings was to determine the need for changes in the National Agricultural Research, Extension, and Teaching Policy Act, Title 14 of the Food and Agriculture Act of 1977 (P.L. 95-113).

The Subcommittee conducted the initial oversight hearings on extension in February and March of 1982; additional follow-up hearings were held in June 1983. The hearings on research were conducted in June 1983, and on higher education in February 1984. The final set of hearings, conducted in June 1984, updated the earlier hearings and focused on critical issues related to needed legislative changes.

Subcommittee Chairman George Brown, Jr. asked the Congressional Research Service to review the hearing records and summarize the key issues for which there is the potential for legislative or administrative changes in policy. Although this collection of issue discussions follows the format of the hearings and is organized into separate sections for research, extension, and higher education, in a number of instances the questions raised may be applicable throughout the science and education system.

A. Barry Carr, Specialist in Agricultural Policy, Environment and Natural Resources Policy Division provided the overall coordination for this project and also authored the issues related to cooperative extension programs. Genevieve

J. Knezo, Specialist in Science and Technology, Science Policy Research Division, provided coordination for the research and teaching issues. Christine Matthews Rose, Analyst in Science and Technology, Science Policy Research Division, was author of the research issues. Edith Fairman Cooper, Analyst in Social Sciences, SPRD, authored the issues related to teaching and higher education.

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REDIRECTIONS FOR THE AGRICULTURAL RESEARCH SERVICE

Issue

Within the past two years, the agricultural research system has been scrutinized extensively by the General Accounting Office, the Office of Technology Assessment, and the Office of Science and Technology Policy. Their reports point out the need for more effective planning and coordination among the components of the system and improvement in the quality of science performed by the system. Concern has been expressed that insufficient planning has resulted in undue overlap of research activities and underutilization of some facilities. The Agricultural Research Service (ARS) released its long-range plan in February 1983 in response to the criticisms made about the system. The major policy issues are: Can the research system be strengthend by eliminating overlap, by better organization, and by clearly defining how it serves national objectives? Will the ARS get the support needed to make changes?

Background

The ARS report, Program Plan: Six-Year Implementation Plan (1984-1990), is intended to guide the Department of Agriculture's operational planning, resource allocation, and program execution for the next six years. 1/ The Plan "reflects the perception by ARS of the short-term goals of the Administration and the Congress." In developing the Plan, the ARS senior staff evaluated agricultural research needs, and recommended redistribution of existing ARS resources among major program areas (soil and water conservation, plant productivity, animal productivity, commodity conversion and delivery, human nutrition, and integration of systems). The redistribution would result in some program areas being emphasized and others deemphasized in accordance with highest agricultural science needs. Some of the major proposals in the Six-Year Plan were to:

(1) reduce plant production and protection research by 18 percent;

(2) increase human nutrition research and commodity conversion and delivery research;

(3) devote about 50 percent of the six-year plan to basic research in all areas;

(4) increase integrated systems research to consider a wide spectrum of interactive variables and constraints;

1/ U.S. Department of Agriculture. Agricultural Research Service Program Plan. Agricultural Research Service. Washington, U.S. Govt. Print. Off., Feb. 1983. 34 p.

(5) reduce substantially most small farm, organic farming, and energy research; and

(6) significantly reduce some commodity research (e.g. cotton) because of an adequate State effort or a lower national priority than other research.

Redirection to these priority activity areas requires not merely the shifting of funds, but also the consolidation of scattered research activities into concentrated centers and the relocation of scientific equipment and personnel.

Analysis

A criticism leveled against the Plan was that it was not detailed enough to determine exactly which locations and projects would be affected. ARS acknowledged that personnel and funding shifts needed to implement the *Six-Year Plan* would be significant. ARS plans to announce these detailed shifts annually.

The Administration's fiscal year 1985 budget did not respond positively to the proposals outlined in the *Six-Year Plan*. The budget did not deemphasize plant production research, despite the major cut proposed for this area in the *Six-Year Plan*. Instead, this area received a substantial increase. Also, human nutrition research, which was a high priority in the *Six-Year Plan*, was the only area not given a program increase.

Concerns were expressed during the June 7, 1984, hearing on "Review of the Department of Agriculture and Joint Council Planning and Priority-Setting Process," about the number of reports being published by the agricultural system. In addition to ARS' *Six-Year Plan*, the Extension Service has prepared a report, *A Perspective for the Future of the Cooper Extension Service*, frequently referenced as the *Extension in the 80's* report, and the Joint Council on the Food and Agricultural Sciences has a *Five-Year Plan for the Food and Agricultural Sciences*. Some House Agriculture Committee members said, during the recent hearings, that more energy is spent in developing plans, than on serving the fundemental purpose of assisting the farmer. Some suggested that if fewer reports were required, Agriculture Department staff might be able to concentrate more on addressing the current and future needs of agriculture by establishing the kinds of priorities that will have an impact on the budget.

ARS acknowledges that the *Six-Year Plan* can be modified as a result of public comments and political considerations. There has been hesitation to implement the Plan rapidly due to congressional concern about ARS' ability to manage research and conduct meaningful long-range planning. Proposed redirections for fiscal year 1985, the second year of the Plan, will be a good indication to Congress of ARS' ability to implement it.

IMPLICATIONS OF THE ANNUAL PRIORITIES AND ACCOMPLISHMENT REPORTS

Issue

The Joint Council on Food and Agricultural Sciences' 1/ fiscal year 1985 annual report, entitled, Priorities for Research, Extension and Higher Education, selected and ranked a number of major priorities for the food and agricultural sciences system. 2/ Five of the eight highest priority areas received no special emphasis in the fiscal year 1985 budget. The extent to which the system is directing resources into the priority areas is questionable.

Background

Section 1407(d)(2)(G) of Title XIV of P.L. 97-98, the National Agricultural Research, Extension, and Teaching Policy Act Amendments of 1981, requires that the Joint Council on Food and Agricultural Sciences develop annual priorities and accomplishment reports. The Joint Council is obligated to produce four reports to help improve the overall effectiveness of the agricultural system: (1) a long-term needs assessment (20-30 years); (2) a five-year plan; (3) an annual priorities report; and (4) an annual accomplishment report.

The report, Needs Assessment for the Food and Agricultural Sciences, released in January 1984, is a comprehensive document which covers all areas of agricultural science. It is intended to serve as a foundation for planning by presenting a broad consensus of the major needs facing the food and agricultural system. The Needs Assessment, not intended to set priorities, is being used to inform policy officials of the most important needs facing agriculture. Based on Needs Assessment findings, broad goals and objectives are set out in the report, Five-Year Plan for the Food and Agricultural Sciences, 3/ and a few are selected for special emphasis in the fiscal year 1985 Priorities report.

Many of the priorities established in the FY 1985 Priorities report did not have a major impact on the proposed fiscal year 1985 budget, as exemplified by the following chart.

1/ The Joint Council on Food and Agricultural Sciences was established in 1977 to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences. Its membership is comprised of representatives from government, industry, and academia. The role of the Joint Council was strengthened in the Agricultural and Food Act of 1981.

2/ U.S. Department of Agriculture. FY85 Priorities for Research, Extension and Higher Education. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., June 1983. 36 p.

3/ U.S. Department of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural sciences. Washington, U.S. Govt. Print. Off., June 1984. 328 p.

Joint Council FY 1985 Priorities(ranked)	FY 1985 Proposed Budget Action
1. Basic Biotechnology Research	Major increase in funding for competitive grants, some in Agricultural Research Service (ARS).
2. Scientific Expertise Development	Termination of fellowship grants.
3. Communications Technology	No increase in Extension Service budget.
4. Analysis of Price and Income Policies with Emphasis on Foreign Trade	Increase in Economic Research Service budget.
5. Sustaining Soil Productivity (controlling soil erosion)	Small increase in ARS and Extension budgets. Termination of program grants for research on soil productivity.
6. Human Nutrition, Including Food Safety and Quality	No increase in ARS or Cooperative State Research Service budget. Major cut in Expanded Food and Nutrition Education Program. Small increase in Human Nutrition Information Service budget.
7. Water Management	No increase in funding.
8. Forest, Range and Pastureland Productivity	Significant cut in Forest Service research. Slight reduction in Cooperative Forestry research budget.

Analysis

The Joint Council's FY 1986 Priorities Report, was scheduled for release in June 1984, and is supposed to rely extensively on Needs Assessment findings. The Needs Assessment merely suggests research priorities. It has been recommended that the priorities be more substantiated and detailed. [4]

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[4] U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Hearings Charter. Needs Assessment. Setting Priorities. 98th Cong., 2d Sess., Washington. (unpublished).

The Joint Council's planning process, as outlined in its four reports, is difficult to evaluate. The complexity of the agricultural system obfuscates a clear statement of priorities as is found in another report, Agricultural Research Service [ARS] Program Plan. 5/ This limitation may derive from the fact that the ARS Program Plan is concerned with only one part of the system, while the reports of the Joint Council focus on the entire system. However, the general findings in both reports are consistent. It will be possible to make a more accurate comparison with the ARS Plan when the Joint Council completes its work on the Five-Year Plan and the forthcoming Annual Priorities and Accomplishments Report.

Questions were raised, during the hearings before the House Committee on Agriculture (June 7, 1984), as to what extent the priority-setting and needs assessment exercises will influence the manner in which science is conducted in the laboratory, greenhouse, and field. 6/ It was the view of William B. Lacy and Lawrence Busch, professors, Rural Sociology, University of Kentucky, that the impact would be negligible. They surveyed more than 1,400 principal investigators engaged in agricultural research at institutions that receive Federal agricultural funds and found that disciplinary criteria and personal preferences dominated the decisionmaking process for most scientists' research agendas, not whether an issue was a national priority or a "hot" topic. 7/

It was recommended that a more effective linkage be established between the priority-setting process and the world of the bench scientist. Nationally established priorities may not have a big impact because of the disciplinary structure of agricultural sciences. U.S. agricultural scientists tend to be unaware of the research being conducted in other disciplines, and the value of that research to their own. 8/

Lacy and Busch found that scientists identified the availability of funding and research facilities as important criteria for research choice. 9/ Lacy

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5/ U.S. Department of Agriculture. Agricultural Research Service Program Plan Six-Year Implementation Plan 1984-1990. Washington, U.S. Govt. Print. Off., Feb. 1983. 34 p.

6/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research and Foreign Agriculture. Review of the USDA and Joint Council Planning and Priority-Setting Process. Hearings, 98th Cong., 2d Sess., June 7, 1984. Hearings Transcript. Testimony of William B. Lacy and Lawrence Busch.

7/ Busch, Lawrence and William B. Lacy. Science, Agriculture, and the Politics of Research. Boulder, Colorado, Westview Press, 1983. 303 p.

8/ Hearings, op. cit.

9/ Busch and Lacy, op. cit.

suggested that the priority-setting process could be linked more effectively to the provision of funds and facilities. Possibly then it would have a greater impact on bench scientists.

He testified that "Congress and the agricultural research community need to combine effective priority-setting with sufficient resources for sustained effort to meet the long-term needs, while retaining the flexibility to respond to urgent short-term problems and coordinating the over all effort." 10/ Many suggestions have been made about ways to improve the planning process. For instance, during the hearings, Lacy suggested that policymakers should continually review and analyze the agricultural policy process. They should:

(1) include the full range of constituents for agricultural research in the process of developing priorities;

(2) establish several multidisciplinary units in which policy research could be conducted;

(3) develop methodologies for interpreting scientific, technical, and economic information in order to increase the effectiveness of research efforts. Resources should be devoted to these new methodologies;

(4) promote closer collaboration between natural and social scientists; and

(5) fund agricultural research at a level more commensurate with its value to society and with its research needs.

10/ Hearings, op. cit.

AGRICULTURAL PRODUCTIVITY--SUPPLY AND DEMAND PROJECTIONS

Issue

One of the most successful sectors of the U.S. economy has been agriculture, with just three percent of U.S. workers producing a surplus of food and fiber for domestic consumption. Since 1980, U.S. exports of agricultural commodities have averaged more than $40 billion annually, up from $10 billion in 1973. In spite of these statistics, concerns are being expressed about the long-term productivity of U.S. agriculture.

Background

"In the coming decades the price of farm products in the U.S. will be influenced not only by constraints on the supply of essential inputs such as land, water and energy, but also by the demands for exports." 1/ U.S. farmers currently produce 13 percent of the world's wheat, 29 percent of the coarse grain, 17 percent of the meat, and 62 percent of the soybeans. With the United States having only five percent of the world's population, there is a large surplus for export. Now, the output of one out of every three acres of U.S. cropland is exported.

Resources for the Future (RFF) estimated supply and demand in the years 2000 and 2020 for the U.S. Department of Agriculture report, Needs Assessment for the Food and Agricultural Sciences. 2/ The report indicated that export trade will be increasingly important for U.S. farmers. But, the tremendous surge in U.S. agricultural exports witnessed during the 1970s is not likely to be repeated in the near future even though overseas demand will increase. To be competitive in world markets will require significant increases in the efficiency and innovative capacity of U.S. agricultural production.

The RFF study assessed not only demand prospects for food, fiber, and forest products in the United States, but also demand and supply prospects of commodities in other regions of the world, as a means of determining potential export demand for U.S. commodities.

The RFF study stated that growth in demand will be particularly large for some developing regions, but that production technology has lagged in these areas. The potential growth of agriculture productivity in the developing countries may constrain the expansion of international agricultural trade and the potential for increased U.S. agricultural sales to these nations.

1/ Batie, Sandra S. and Robert G. Healy. The Future of American Agriculture, Scientific American, v. 248, no. 2, Feb. 1983: 45.

2/ U.S. Dept. of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Science, Washington, U.S. Govt. Print. Off., Jan. 1984. p. 9-100.

Analysis

In written testimony before the House Committee on Agriculture (June 7, 1984) Kenneth R. Farrell, Director, National Center for Food and Agricultural Policy, stressed that the results of the RFF study are not predictions or forecasts of what will happen. "Our projections can best be viewed as central tendencies of future changes--a general path of change based on trends of future and realization of key assumptions which undergird changes in demand, supply, and trade." 3/

Major implications and conclusions drawn from the study that might warrant congressional attention are:

(1) The long-term challenges for meeting growth in demand for U.S. agricultural and forestry sectors are formidable. Without continued growth in productivity from technologies developed from increased research, there might be increased pressures on the natural resource base. There has been little growth in Federal support for agricultural research since 1975. Congress might wish to reverse this trend by providing increased funding for agricultural research. It has been estimated that in order to meet the demands projected in the RFF study for 2020, public funding will need to be increased at a compound annual rate of ten percent between 1983 and 1994, with funding between 1994 and 2020 maintained at the real investment level of 1994 and as a constant proportion of the value of agricultural and forestry output over the 40 years. 4/

(2) The growth in demand for U.S. products is likely to be erratic. To ensure competitiveness in world markets, it has been considered important to continue to invest in productivity-enhancing research as a means of maintaining competitiveness.

(3) It may be necessary to develop socially appropriate technologies, that meet not only agricultural needs, but also competing social goals. Federal investments may be required in studies of human development and social science research to improve understanding of human and institutional behavior in the agriculture sectors.

3/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of the Department of Agriculture and Joint Council Planning and Priority-Setting Processes. Hearings, 98th Cong., 2d Sess., June 7, 1984. Hearings transcript, written testimony.

4/ U.S. Department of Agriculture. Reference Document, op. cit. p. 86.

FUNDING FOR INTERDISCIPLINARY RESEARCH WITHIN THE AGRICULTURAL SCIENCE SYSTEM

Issue

Interdisciplinary skills and training will be required to meet many of the emerging priorities in the agricultural research system, specifically in genetic engineering, monoclonal antibody technology, and tissue culture technology. In order to stimulate interdisciplinary research to address regional or national priorities, innovative funding and a loosening of the disciplinary boundaries within the sciences may be needed.

Background

Interest has been generated in interdisciplinary research because achievement of many of the necessary research goals in biotechnology and agriculture requires the integration and collaboration of several disciplines. In 1979, when the McKnight Foundation decided to fund "state-of-the-art" research that could be expected to have a positive impact on agricultural production in the year 2000 and beyond, it realized that its objective required varying degrees of integration and coordination of the research interests of individuals from divergent backgrounds. The Foundation designed its program to fund not only individual scientists, but also groups of scientists who were working in an interdisciplinary mode, in order to accomplish objectives which can only be achieved by pooling diverse talents. The awards permit approaches to research and training that are presently not available through the usual granting channels. The programs, which were initiated in 1979, earmarked a major fraction of funding for research by graduate students. This was done to emphasize the need to prepare those who will provide the scientific expertise in the year 2000 and beyond. The Foundation will award $1,850,000 per year for ten years. 1/

Analysis

Development of interdisciplinary research remains inhibited in most colleges of agriculture. However, the McKnight Foundation has been instrumental in stimulating discussion in different universities on ways to structure their faculties and research efforts so as to encourage much more interdisciplinary research and training. Where once reluctant, some universities, heightened by the interest in biotechnology, are looking at interdisciplinary research as a means to develop new associations between their faculties and the private sector. New and creative funding mechanisms like the McKnight Awards for

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1/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of USDA's Biotechnology Research Program Plans, Regulatory Concerns and Public Benefits. June 6, 1984, 98th Cong., 2d Sess., Hearings Transcript. Testimony by Richard Caldecott.

Interdisciplinary Research Projects in Plant Biology might help to guarantee the scientific infrastructure and the financial support needed for interdisciplinary research for the agricultural sciences.

In testimony before the House Committee on Agriculture, William B. Lacy, Associate Professor, Rural Sociology, University of Kentucky, contended that increasing the capacity of the current agricultural research system to engage in interdisciplinary research may require not only changes in the training of scientists, but also modifications of agricultural research strategies, methods, and organizational structures. He recommended that steps be taken by Federal and State funding agencies, as well as universities themselves, to:

(1) provide fellowships and assistantships to graduate students to pursue minors outside their disciplines (agronomists might minor in animal nutrition);

(2) provide funding for faculty to take sabbatical and postdoctoral leave at non-land grant institutions and in disciplines other than their own;

(3) reorganize the current reward system in agricultural research institutions to encourage scientists to pursue more high-risk, interdisciplinary, and long-term research that addresses national priorities; and

(4) encourage the establishment of multidisciplinary, multicommodity research projects and programs, through a granting process or through a requirement for continued levels of funding. 2/

2/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of the USDA and Joint Council Planning and Priority Setting Processes. June 7, 1984, 98th Cong., 2d Sess., Hearings Transcript. Testimony by William B. Lacy.

A SOCIAL SCIENCE AGENDA FOR AGRICULTURAL RESEARCH

Issue

Technological advances made in agriculture have continuously influenced who farms and owns U.S. lands, and the techniques of environmental management and resource development of the land. The agricultural research agenda has broadened to encompass most of the advances of the natural science-based disciplines, but, some critics contend, not those of social science-based disciplines. Too little attention seems to have been given to positive and negative economic and social consequences resulting from technological development in agriculture. The potential social benefits and costs of the emerging technologies may need to be identified better.

Background

The subject matter of the social sciences in agricultural research is human institutions. Social science intersects with the natural sciences at the farm level, where food and fiber are produced; at the community level, where support services for agricultural production and rural people are organized; and at the national level, where the terms on which consumers have access to the products of agriculture and agricultural producers have access to the products of industry are determined. 1/ Agricultural economics, as a social science, deals with the factors affecting costs of production, the behavior of agricultural commodity markets, and the economics of farm management and land use. Rural sociology aims to improve understanding of the behavior of rural society, economy, and policy. Agricultural social science, as a whole, is interested in the range of incentives and institutional innovations guiding further technological advances and in the compensating mechanisms that may need to be adopted as a result of such advances.

The social science research agenda in the agricultural system has been heavily weighted toward economics. Although most agricultural research programs have social science representation, agricultural economics is the only field that is fully represented in most agricultural research institutes, agricultural experiment stations, and agricultural agencies. Other social science disciplines, which have the capacity for understanding basic behavioral relationships, cultural patterns, and organizational dynamics, and can estimate the consequences of policies, have not been adequately represented on agricultural research policy agendas, according to testimony delivered in 1984 by William B. Lacy. 2/ In a paper presented at the annual meeting of the American Association for

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1/ Ruttan, Vernon, W. Agricultural Research Policy. Minneapolis, University of Minnesota Press. 1982. 369 p.

2/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of USDA and Joint Council Planning and Priority-Setting Processes. Hearings, 98th Cong., 2d Sess., June 7, 1984. Hearings Transcript. Testimony by William B. Lacy.

the Advancement of Science, May 1984, Robert W. Werge, U.S. Department of Agriculture, wrote that "A focus on organizational culture and behavior within agricultural research systems by social scientists is essential to greater integration of social and biological science at the farm level and on the level of multidisciplinary research teams." 3/

Analysis

There is criticism about some chemical and biological innovations in the agricultural system and increasing concern about the environment from farm pollutants. In testimony before the House Committee on Agriculture, Ralph Hardy, Board of Agriculture, National Research Council, said "Agriculture must communicate more effectively with society so that society's views are based more on reality than blanket impressions about broad areas such as genetic engineering and plant protectant chemicals." 4/ Additional knowledge from the social sciences could be instrumental in reducing the tension that exists in society.

The technologies of the future suggest a broader research agenda for the social sciences and agriculture. Michael J. Phillips, Project Director, Food and Renewable Resources Program, Office of Technology Assessment, concluded that new priorities for social science research should include:

(1) studies analyzing prior research progress and the distributional consequences of these research programs;

(2) assessment and design of new technologies so as to anticipate and avoid undesirable externalities; and

(3) development of new institutions, or adaptation of old institutions, to ensure, or at least facilitate, desirable public outcomes. 5/

More attention might be given also to social science research relating to nutrition and to food processing and delivery. The effective implementation of such an agenda seems to require more interdisciplinary research linking the biological, physical, and social sciences.

3/ Werge, Robert W. Social Science Contributions to the Management of Agricultural Research. U.S. Department of Agriculture. Paper presented before the Annual Meeting of the American Association for the Advancement of Sciences. May 1984.

4/ U.S. Congress. House. Commitee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of USDA's Biotechnology Research Program Plans, Regulatory Concerns, and Public Benefits. Hearings, 98th Cong., 2d Sess., June 6, 1984. Hearings Transcript. Testimony by Ralph Hardy.

5/ Phillips, Michael J., Social Science Implications of Agricultural Science and Technology: Discussion. American Journal of Agricultural Economy. Dec. 1983.

Additional public attention might be directed to ensuring that there is adequate Federal support for social science research relevant to agriculture in The Department of Agriculture and the National Science Foundation, and that those agencies support interdisciplinary research to integrate the knowledge bases of relevant disciplines in the agricultural area.

A NATIONAL PROGRAM FOR BASIC RESEARCH IN BIOTECHNOLOGY FOR AGRICULTURE AND FOOD

Issue

About one to two percent, at most, of the gross market value of U.S. agricultural products is spent on research. It has been alleged that this represents an underinvestment in agricultural research which threatens the health and vitality of U.S. agriculture. Some agriculture scientists and policymakers believe that the Department of Agriculture's (USDA) competitive grants program can be used more effectively to support agricultural research, including biotechnology research, and that an enlarged major competitive grants program might reverse the trend of underinvestment.

Background

The National Association of State Universities and Land Grant Colleges (NASULGC) Committee on Biotechnology, in its Progress Report II, November 1983, identified major needs and opportunities for enhancing the application of biotechnology research accomplishments to agriculture and food. 1/ The Committee proposed that a new national competitive grants program be established to ensure adequate basic research in biotechnology for agriculture. Some of the major requirements proposed were that the program: (1) be open to all scientists in public and private universities, State agricultural experiment stations, research institutes, and government laboratories; (2) complement existing programs in the Department of Agriculture (USDA), National Science Foundation, and National Institutes of Health; (3) cover the basic principles utilizing plant, animal and microbial systems; and (4) allocate funds on the basis of competitive-merit, with all research being investigator-initiated and peer-reviewed.

The proposed program is intended to fill in the gaps in the many existing Federal programs of funding for agricultural research, including the USDA's program of competitive grants. The Committee on Biotechnology stressed that the program must augment existing research and education programs, but must not replace or redirect current programs. The program would be administered by USDA in a manner compatible with the competitive grants program.

The Committee on Biotechnology projected an annual budget for the national biotechnolgy initiative of $70 million (research grants, $51 million; fellowships, $5 million; and equipment grants, $24 million). This figure is four

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1/ National Association of State Universities and Land-Grant Colleges. Division of Agriculture, Committee on Biotechnology. Emerging Biotechnologies in Agriculture: Issues and Policies. Progress Report II, Nov. 1983. 85 p.

times the size of the current USDA total competitive grants program. Based on a survey of the present faculty effort in biotechnology, in just the State agricultural experiment stations, the $70 million would provide research support for only 23 percent of the faculty, six percent of the pre-doctoral students, and eight percent of the new faculty at the desirable award levels. 2/

It has been recommended by the House Committee on Agriculture that better linkages be developed between the traditional sciences and the new biotechnology disciplines. 3/ The NASULGC Committee on Biotechnology proposed a program of multidisciplinary research grants (at least $200,000 per year for at least five years). This might support research to augment understanding of the linkages between basic molecular biology, genetics, and breeding--for both plants and animal systems.

Analysis

The NASULGC Committee on Biotechnology proposed the removal of the $50 million ceiling on competitive grants, that is authorized in Title XIV-National Agricultural Research, Extension, and Teaching Policy Act Amendments of 1981 (Farm Bill). This cap forced the Department to request funding for the competitive grants biotechnology program in the fiscal year 1985 budget at the level of $28.5, million, which is below the level recommended by the Committee on Biotechnology. The Committee recommended that any revisions of Title XIV of the Farm Bill include language removing the $50 million ceiling.

Because of the reduced level of funding ($28.5 million rather than $70 million) the NASULGC Committee recommended that emphasis be placed on research grants. Inclusion of graduate and post-doctoral students in the grants should be encouraged, according to the Committee. This would help to educate more scientists in agricultural applications.

USDA may have difficulty operating an expanded competitive grants program. The Office of Grants and Program Systems (OGPS), which operates the Competitive Research Grants program, has no separate budget account or budgeted personnel ceiling. Even if OGPS could be allocated more staff positions, the agency will not know the congressional funding level for fiscal year 1985 until it is too late to hire additional staff for the next grant cycle. Earlier attention to personnel needs may be necessary.

2/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Hearings Transcript. Extension in the 80's--Accountability Issues, Formula Change, and Computer Technology. June 12, 1984. 98th Cong., 2d Sess., testimony by Theodore L. Hullar

3/ U.S. Congress. House Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Hearings Charter. Biotechnology. USDA Plans, 98th Cong., 2d Sess., Washington (unpublished).

The House Appropriations Committee recommended a fiscal year 1985 budget level of $10 million for biotechnology competitive grants, a figure which is one third of the requested level. Some House members favor funding research in traditionally important fields and are skeptical about a competitive grants program, as opposed to formula funding. The Senate Appropriations Committee reported a bill allowing $28.5 million, the amount the Administration requested. If the Congress elects to decrease funding for USDA's biotechnology competitive grants program below the level recommended by the Committee on Biotechnology, the Congress may consider expanding the National Science Foundation's biotechnology program.

ISSUES IN THE COMMERCIALIZATION OF UNIVERSITY-INDUSTRY BIOTECHNOLOGY RESEARCH

Issue

Biotechnology research requires a substantial investment. Universities, faced with declining Federal funding of basic research, have turned to industry as a potential source of revenue for supporting agricultural research. Industry sponsors joint ventures, contracts, grants, and consortiums with universities to conduct cutting-edge agricultural research. Despite the benefits of industrial funding, concerns have surfaced in the agricultural research community the propriety of the close working relationships being established between universities and industry. Will lucrative consulting arrangements with industry cause faculty to neglect their teaching and public service obligations? Will conflict-of-interest issues arise among scientists who are involved in profitable research projects with industry? Will interest in basic agricultural research diminish?

Background

In the last few years there has been increasing commercialization of biotechnology research through joint university-industry research. The Patent Reform Act of 1980 has done much to clarify the patent relationships among universities, corporations, and the Federal Government. The Act, which took effect July 1, 1981, provides a single Federal-wide policy on the allocation of patent rights resulting from federally supported research and gives preferential benefits to universities, small business firms, and non-profit organizations. The Act requires that universities be given preferential title rights to inventions made under federally funded R&D. Its intent is to encourage cooperation between universities and industry by allowing the universities to offer future licenses in exchange for support even if Federal money is involved. Some reported arrangements are

-Yale University signed a three-year $1.1 million research contract with the Celanese Corporation. Celanese is interested in learning how to use naturally occurring enzymes in the manufacturing of chemicals and fabrics.

-Rockefeller University and Monsanto Company announced a five-year $4 million agreement under which Monsonato will support basic research in plant molecular biology at the University.

In addition to such arrangements, various State legislatures are appropriating special funds to support university-industry research. The public funds are being used to stimulate private matching funds.

Although industrial resources significantly augment university research capabilities, many questions have been raised about the potential negative implications of these arrangements. Some critics question the impact of such ventures on the university. Will private research projects conflict with the teaching responsibilities of professors involved? Is it ethical for graduate students to assist a professor in research being done to facilitate the professor's private commercial interests? Also, what type of impact will this kind of research have on basic agricultural research? The new biotechnology companies are prepared to pay salaries much higher than the academic community. The possibilities exist that not only will faculty members be hired away from the universities, but also that they may leave to form their own companies. If university faculties are being recruited for industry jobs, will enough faculty remain to teach the next generation of scientists? Also graduate studies are leaving to work in industry rather than finishing degrees and teaching.

The problem in some cases, according to one critic, Marty Strange in his article, "Who Pays for Agricultural Research," is that private companies support primarily applied research because the time spent on this research is much shorter and usually has immediate value to the company. 1/ Basic research, on the other hand, is longer-term and usually does not produce immediate results as profits. Some scientists and policy makers are concerned, because while applied research produces quicker results, such findings depend on fundamental knowledge which is obtained through basic research. 2/

The Division of Agriculture, Committee on Biotechnology, of the National Association of State Universities and Land-Grant Colleges (NASULGC), has been working to expand private funding of biotechnological research in State agricultural experiment stations and universities, as well as to alleviate potential problems which might result from such arrangements. In testimony before the House Committee on Agriculture (June 6, 1984), Theliam R. Baumgardt, Director, Indiana Agricultural Experiment Station, listed some of the efforts of the committee. 3/ They include improving:

-- tax considerations for various funding arrangements;

-- information on appropriate use of patents and Certificates of Plant Variety Protection;

-- guidelines for the development of a university/industry research contract; and

-- guidelines for faculty consulting in the private sector.

Groups have convened to discuss ethical concerns flowing from university-industry efforts. Yale University has formed an Office of Cooperative Research to strengthen links between universities and corporations. The NASULGC Committee on Biotechnology has developed a concise statement of patent law, giving the requirements for patent applications and the circumstances under which patent protection might be denied. It also has established a Subcommittee on

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1/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations Research and Foregin Agriculture. Review of USDA's Biotechnology Research Program Plans, Regulatory Concerns and Public Benefits. Hearings, 98th Cong., 2d Sess., June 6, 1984. Written testimony.

2/ Strange, Marty. Who Pays for Agricultural Research? Prairie Sentinel, Feb. 1982. p. 10.

3/ Ibid.

Social and Ethical Issues, and has met with the Industrial Biotechnology Association to discuss industry and university relationships with specific reference to manpower needs, graduate education, applied and basic research priorities, financing biotechnology research, and consulting.

The President of the Association of American Universities (AAU), Robert Rosenzweig, stated recently that, "the desire to attract more industrial research to the campus has created the need to understand the legal and ethical issues" regarding ventures which might cause conflicts-of-interest. 4/ The AAU has created a Clearinghouse on Corporate/Academic Ties which surveys how various institutions are organising working relationships with industrial firms and, at the same time, are avoiding conflicts-of-interest. A report on the findings is forthcoming. 5/

Analysis

Industrial support of biotechnology research in universities augments other funding sources and enhances the capacity to conduct basic and applied research. The possible drawbacks of such funding are reflected in concerns about conflicts-of-interest and ethics, which professional groups are now addressing. The proposed expansion of the competitive research grants program, funded by USDA, may satisfy those critics who believe that universities should fund more basic research to complement the applied research funded by industry at universities.

Despite those concerns there seems to be a general consensus about the need to increase industrial funding for university research. The NASUGLC Committee on Biotechnology recommended that Congress take action as soon as possible to increase incentives for industrial support of university research. 6/ Some suggestions are to:

(1) increase capabilities for corporations to receive tax credits for research at universities. Some have suggested that 100 percent tax credit be given on net earnings for all corporate funding granted to do basic research at universities;

(2) develop further tax credits for research and development equipment donated by corporations to universities. Some say that the current tax laws do not give corporations sufficient tax credits to induce additional equipment donations;

4/ Lepkowski, Wil. University/Industry Research Ties Still Viewed With Concern. Chemical and Engineering News, v. , June 25, 1984. p. 11.

5/ Ibid.

6/ National Association of State Universities and Land-Grant Colleges. Division fo Agriculture Committee on Biotechnology. Emerging Biotechnologies in Agriculture: Issues and Policies. Progress Report II., Nov. 1983. 85 p.

(3) remove the provision of Section 1235(a) of the Internal Revenue Service code to make it possible for universities to own completely the rights to inventions made with venture capital and to permit research and development limited partnerships to retain tax benefits. This would make it easier for universities to continue their tradition of patent ownership.

EFFECTS OF NEW PLANT BIOTECHNOLOGIES ON AGRICULTURAL RESEARCH

Issue

There is a consensus in the agricultural community that genetic engineering will have a profound impact on the future of the food and farm system. Genetic engineering in plant breeding is expected to add $5.6 billion to the annual value of crops before the year 2000. The impacts of the breakthroughs in the new plant biotechnologies will exceed those of the development of iceberg lettuce in the 1920s or of hybrid corn in the 1930s. But, the biotechnology revolution will come at a price. The continuous infusion of the new biotechnologies into the competitive agricultural market may have unanticipated effects.

Background

The National Science Foundation conducted a study, through its Program on Ethics and Values in Science and Technology, to examine the impacts of the new plant biotechnologies on breeding. The findings from that study foresee changes in farm production and agribusiness and in the functions of agricultural research and education. 1/

A shift of disciplines appears to be occurring in the agricultural experiment stations. Much of the expertise in biotechnology lies outside the land grant universities, while most plant breeding expertise lies within the institutions. Microbiologists and molecular geneticists, once employed largely in colleges of science and medicine, are beginning to replace plant breeders in agricultural experiment stations. A report prepared by the National Association of State Universities and Land-Grant Colleges, estimates that an additional 108 full-time scientists will be added in the biotechnology disciplines within the next two years. 2/ Many of these positions will be filled at the expense of conventional plant breeding scientists. Because biotechnologists and plant breeders differ with respect to work environment and location within the scientific community, most biotechnologists have had little connection to farm life.

Another consequence of the new biotechnologies is the high cost of construction, maintenance and instrumentation. Every State has been able to afford a conventional breeding program, but every State might not be able to afford a comprehensive plant biotechnology program. The resulting effect might be a limitation on the number of States that can engage in a full-fledged biotechnology program, and a concentration of scientific talent at a few public and private institutions.

1/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research and Foreign Agriculture. Review of the USDA and Joint Council Planning and Priority-Setting Processes. 98th Cong., 2d Sess., June 7, 1984. Hearings Transcript. Testimony by Lawrence Busch.

2/ National Association of State Universities and Land-Grant Colleges. Division of Agriculture Committee on Biotechnology. Emerging Biotechnologies in Agriculture: Issues and Policies. Progress Report II, Nov. 1983. 85 p.

Structural and behavioral changes are occuring in the seed industry as a consequence of the new biotechnologies. The large seed companies have continued to monopolize the market for major crops while the small seed companies are being confined to local markets. The seed industry also is pressuring experiment stations to reduce their role in the release of finished varieties and is encouraging them to restrict themselves to basic research. Some universities have even reduced or eliminated their corn breeding program. 3/

The private sector tends to use new biotechnologies differently from the public sector. Instead of developing insect-resistant varieties, some industries are developing pesticide-resistant varieties. 4/

Probably the most dramatic effect of the new biotechnology will be on the farmer. Production in the seed industry is gradually being moved from the experiment stations to the industrial sector. It is possible that farmers will gradually lose their traditional role as primary clients for plant breeding research. To some extent, farmers have already been replaced by chemical and seed companies. The new biotechnologies have the ability to make farmers dependent on industry in a manner in which they never have been before. There is the potential for conflict between the interests of the farmer and those of agribusiness.

Analysis

Several issues appear to require additional public policy consideration. One is the issue of ample and equitable sources of funding. In testimony before the House Committee on Agriculture, Lawrence Busch, Co-Chair, Committee for Agricultural Research Policy, University of Kentucky, stated "Perhaps the major policy implication of . . . [the NSF] . . . study is that certain aspects of the new biotechnologies are unlikely to be developed unless Federal money is available for research and education. While State and private funds are already addressing some issues effectively, much of the potential for the new plant biotechnologies will only be realized if Federal monies are made available in a relatively unfettered manner." 5/ A second issue is that the new biotechnologies have the potential for altering U.S. agriculture and agricultural research. In addition, unanticipated consequences may be expected. Congress may want to intensify its oversight and monitoring of progress and innovations in this area.

3/ U.S. Congress. House. Committee on Agriculture. Hearings, op. cit.

4/ Ibid.

5/ Ibid.

THE INTRODUCTION OF BIOLOGICAL CONTROL ORGANISMS IN THE ENVIRONMENT

Issue

Biological control can provide great economic benefits. But, as with all ecosystem manipulations, there are potential risks. There is great uncertainty concerning the regulation and release of new organisms created by biotechnology research. At the present time, environmental effects associated with the deliberate release of genetically engineered organisms are difficult to predict. What type of regulatory approval processes are needed for release of new organisms to ensure protection of the environment without inhibiting the potential of biotechnology in agriculture?

Background

Since the Supreme Court ruling in 1980 which allowed genetically engineered life forms to be patented, pressure has been placed on regulatory agencies to monitor the biotechnology industry. The testing and commercialization of these modified organisms has raised enormous questions concerning the ability of existing regulatory structures to deal effectively with the commercialization of biotechnology.

In June 1983, joint hearings were held by the House Committee on Science and Technology's Subcommittees on Science, Research, and Technology and on Investigations and Oversight, on the safety of gene manipulation. A staff report of those hearings, "The Environmental Implications of Genetic Engineering," was released in February 1984 (commonly referred to as the Gore report). 1/ Some of the major findings and recommendations from that report are:

(1) An interagency advisory committee is needed to review all proposals for deliberate releases of new organisms. The committee should be organized by the Environmental Protection Agency (EPA).

(2) EPA should extend its jurisdiction over all deliberately released organisms not specifically identified as part of the legal obligation of another agency. EPA should limit its oversight activities undertaken pursuant to the Toxic Substances Control Act (TSCA). EPA is now working on a proposed rule.

1/ U.S. House. Committee on Science and Technology. Subcommittee on Investigations and Oversight. The Environmental Implications of Genetic Engineering. 98th Cong., 2d Sess., Feb. 1984. 12 p. (Committee Print.)

(3) The Department of Agriculture (USDA) has potential regulatory jurisdiction under the Animal Plant Health Inspection Services' (APHIS) statutes intended to control introduction of harmful organisms. The General Accounting Office (GAO) has been asked to investigate the scope of USDA's jurisdiction in this area.

(4) Current National Institutes of Health (NIH) and its Recombinant DNA Advisory Committee (RAC) oversight is limited to research projects that receive Federal funding. Commercial firms' comcompliance is voluntary.

(5) NIH and USDA should revise the membership of their RAC's to include individuals specifically trained in ecology and in the environmental sciences.

On May 16, 1984, Judge John Sirica issued an injuction preventing the field testing of bacteria which lack the ability to form frost on plant surfaces. The experiment, involving the deliberate release of gene-engineered organisms in the environment, is being challenged in court by environmentalists who contend that the NIH RAC violated the law in approving the experiment prior to fully assessing its environmental impact. If Judge Sirica's decision stands, it could be several years before recombinant DNA technology, especially agricultural work, could be practiced in federally funded institutions in the United States. If the plantiffs win this suit, it might have a negative impact on the transfer of DNA technology to the industrial sector. At the same time, the class action provides a forum in which the standards and practices currently in place can be assessed.

Analysis

EPA's move to claim jurisdiction over all deliberately released organisms and Judge Sirica's injuction imposed on the gene-engineered experiment have had a disquieting effect on both public and private biotechnology research. Investment in biotechnology research may be slowed by court challenges and Federal review of each new product. Special legislation enacted by Congress providing clear guidelines might reduce court challenges in the future.

In testimony before the House Committee on Agriculture, John Marvel, Research Manager, Monsanto Agricultural Products Company, stated that the current regulatory climate is "impeding progress and must be stabilized." 2/ EPA contends that it has authority to regulate recombinant DNA under TSCA, but the scope of the act is not clear and it may require greater scientific and legal definition.

2/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research and Foreign Agriculture. Review of USDA and Joint Council Planning and Priority-Setting Processes. Hearings, 98th Cong., 2d Sess., June 7, 1984. Hearings Transcript. Testimony by John Marvel.

The National Agricultural Research and Extension Users Advisory Board 3/ has recommended the establishment of a temporary national Biotechnology Coordinating Commission to ensure that the regulation of the biotechnology industry is effective, scientific, and in the public interest. 4/ During his testimony, Marvel presented an overview of the proposed Commission's structure and functions. He said that the Commission should be independent, with the Director appointed by the President and confirmed by the Senate. The Commission should include representatives from EPA, USDA, Food and Drug Administration, Occupational Safety and Health Administration, the scientific community, and the public. The Commission should operate for not more than one year to ensure that present organizational and functional problems are solved without creating a new permanent layer of regulatory activities. The Commission should also be multidisciplinary, including theologians.

The Users Advisory Board has recommended that the Biotechnology Coordinating Commission have the following functions:

(1) define interagency lines of jurisdiction and authority for guidelines and regulations for research, development, and product registration for current and anticipated needs;

(2) provide an information clearing function to direct questions to the appropriate agency;

(3) ensure that each regulatory agency, or some other existing agency, establish an ongoing dialog with both public and private sector, to assure progress of biotechnological sciences and protection of the public; and

(4) give greater consideration to the protection of intellectual property rights. Proper and effective protection of intellectual property rights will provide necessary incentives for more companies to engage in new research.

3/ A statutory committee established by the National Agricultural Research and Extension and Teaching Policy Act of 1977, as revised by the Agriculture and Food Act of 1981 (P.L. 97-98). The Board has the general responsibility for preparing independent advisory opinions on the food and agricultural sciences. The Board's 25 members represent the multiple interests of all users of the Nation's agricultural science and education systems.

4/ U.S. Congress. House. Committee on Agriculture. Hearings., Op. cit., June 7, 1984.

When the biotechnology industry reaches the level of large-scale releases through commercial application of genetically engineered organisms, protocols will need to be established. NIH's RAC has dealt with review of experiments only at the research level. The Users Advisory Board said that the RAC committee had done an adequate job, but that proper guidelines and rules will have to be established when research moves out of the laboratory into the commercial phase. The study presently being conducted by GAO, pursuant to the Gore report, on USDA's regulatory jurisdiction, might provide Congress with additional options for structuring of the regulatory process. Alternatives could also be investigated at future oversight hearings dealing with Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and APHIS.

IMPACT OF NEW TECHNOLOGIES ON FARM STRUCTURE

Issue

Technological change has been the dominant factor in changing the structure of agriculture. The complexity and diversity of the farm system makes it extremely difficult to measure the magnitude and the direction of the effects of technological breakthroughs. Concern is being expressed that many of the new technologies will provide benefits for the larger agri-business enterpreneur at the expense of the smaller farmer. Such a trend might continue if a profitable and diverse farm sector is not stimulated.

Background

Farm structure has undergone continuous change during the development of modern agriculture in the United States. Between 1950 and 1980, the number of people living on farms fell from 23 million to fewer than eight million, and the average size of farms doubled to just over 400 acres. In 1981, agricultural production units were made up of 112,000 large farms, which produced 49 percent of the U.S. farm output; 582,000 medium-size farms, which produced 38 percent of the output; and 1,742,000 small farms, which produced 13 percent of the output. 1/ Income based on farm sales tended to be concentrated in the larger farms. Most agricultural policy experts believe such structural changes will continue, but they disagree about the rate of such changes.

Projections published in U.S. Farm Numbers, Sizes and Related Structural Dimensions: Projections to the Year 2000 show that the proportion of medium sized U.S. farms will decrease and the proportion of large and small farms will increase. "Land ownership will be dominated by fewer farms, and by the year 2000, the largest one percent of the farms will account for about 50 percent of total farm production. About 50 percent of the farm land will be farmed by the largest 50,000 farms and about 2/3 of the wealth in the agricultural sector will be in the hands of the top 20 percent of farmers." 2/

The report, Needs Assessment for the Food and Agricultural Sciences, discusses farm adjustment problems caused by the new technologies, but does not call for solutions to these complex problems. 3/ The report acknowledges that

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1/ U.S. Department of Agriculture. Summary: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., Jan. 1984. p. 44.

2/ Lin, William, George Coffman, and J. B. Penn. U.S. Farm Numbers, Sizes, and Related Structural Dimensions: Projections to the Year 2000. Tech. Bullentin, 1625, USDA, ESCS, July, 1980. In Butler, L. J. and Allan A. Schmid The Farm and Food System in Transition. Emerging Policy Issues. Published by U.S. Department of Agriculture. Cooperative Extension Service, 1984. p.2.

3/ U. S. Dept. of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Sciences, Washington, U.S. Govt. Print. Off., Jan. 1984. p. 300.

most new technologies will yield greater volume for farmers who adopt the technology early, and result in a reduced number of farms. The *Needs Assessment* states that social scientists might be able to predict the consequences of policy choices and new technologies if they provided " . . . improved research, behavioral studies, and data that are basic to future policy considerations."

Analysis

The *Needs Assessment* raises questions about the relationship between technology and farm structure, but does not propose any solutions. The report does, however, list agricultural policy research needs. Issues flowing from the application of new technologies were not addressed fully in the *FY 1985 Priorities for Research, Extension and Higher Education Report*, and may not be highlighted in the upcoming *FY 1986 Priorities Report*. An issue warranting possible additional Congressional attention is the Department of Agriculture's plans to consider the farm adjustments that might be caused by new directions of future farm technology.

The Office of Technology Assessment (OTA) is conducting an assessment of emerging agricultural technologies and their relationship to public policy. This study was requested by the Subcommittee on Department Operations, Research, and Foreign Agriculture, along with other subcommittees of the House Agriculture Committee. The study, entitled "Technology, Public Policy and the Changing Structure of American Agriculture", will examine the supply and demand for U.S. agriculture in the year 2000, explain the impact of technological advances, and analyze public policies in relation to potential benefits and costs.

In testimony before the House Committee on Agriculture, Dr. Michael Phillips, Director of the Food and Renewable Resources section of OTA said that preliminary findings indicate that biotechnology, information, and communications technologies will have a profound impact, resulting in structural changes. 4/ New technologies will increase yield, improve quality, decrease cost of production, and expand useful world cropland. OTA will submit an interim report from the study to be used in consideration of the 1985 Farm Bill later this year. The completed assessment is scheduled for release in 1985.

4/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research and Foreign Agriculture. Review of USDA and Joint Council Planning and Priority-Setting Processes. 98th Cong., 2d Sess., June 7, 1984. Hearings Transcript, 2d Sess.

ENVIRONMENTAL IMPACT OF AGRICULTURAL PESTICIDES

Issue

Empirical data indicate that during the 1950s and 1960s the benefits associated with pesticide use were obtained at substantial cost. These costs included development of genetic resistance in target populations, damage to non-target species of plants and wildlife populations, destruction of beneficial insects, and detrimental effects on human health and reproductive capacity. A recent survey indicated that 77 percent of the public consider pesticide residues to be a serious hazard. What needs to be done to assure that pesticides are not adversely affecting the environment? What will satisfy the demands of environmentalists and the demands of farmers?

Background

The estimated total environmental costs of pesticide use in the United States is set at $839 million annually. Included in this figure are categories of environmental cost, ranging from reduced natural enemies and increased resistance to pesticides ($287 million), to fish and wildlife losses ($11 million). Pesticide poisonings, including those that result in fatalities, are estimated to cost $184 million. 1/

There have been attacks on the use of pesticides, the industry which supplies them, and the agriculturists who advocate their use. Pesticides, which ultimately end up in the soil, behave not only according to the properties of the chemical themselves, but also react with the particular matter with which they come in contact. Sometimes soil microorganisms can break down pesticides before they take effect. The major concern is that no one knows with any precision what happens to pesticides when they leave the farmer's field. Pesticides may seriously damage the delicate composition of the soil and reduce the long-term soil productivity.

The U.S. Department of Agriculture report, *Needs Assessment for the Food and Agricultural Sciences*, addresses the issue of pesticide use. 2/ The report accepts projections of increased pesticide use, mostly due to increasing herbicide use, as more farmers adopt conservation tillage methods, which are advocated in order to prevent erosion of topsoils. Although it recognizes gaps in knowledge about long-term effects of present application rates, the report does not emphasize understanding the effects of pesticide use on long-term soil fertility as a major research area. The *Needs Assessment* does, however, advocate more targeted biological control systems having fewer environmental hazards, such as integrated pest management.

1/ Crosson, Pierre R. Resource and Environmental Effects of U.S. Agriculture. John Hopkins University Press, 1982. p. 33.

2/ U.S. Department of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., Jan. 1984. p. 131.

The Joint Council on Food and Agricultural Sciences' study, *FY 1985 Priorities for Research, Extension, and Higher Education*, selected eight national priorities. 3/ Sustaining soil productivity was ranked number five on the list of eight priorities. The Joint Council's report focuses on the negative impact of soil erosion by wind and water, and does not emphasize the need for research on the long-range detrimental effects on the environment which may result from pesticide use.

Analysis

There does not appear to be enough adequate scientific knowledge of microbial activity in soils to show definitively that pesticides are producing long-range adverse effects on soil processes. It is difficult to respond to criticisms until the agricultural research system understands the chemical and biological properties of soil as they relate to soil fertility. In testimony before the House Committee on Agriculture, Jerome B. Weber, professor in the Crop and Soil Science Department at North Carolina State University stated that " . . . pesticides which are presently being used are as safe to the environment as commonly used pharmaceuticals are to human health. For both examples, misuse can lead to disaster, and proper use can lead to great benefits." 4/

Recommendations have been made for the Environmental Protection Agency to assemble a package of industrially generated information about the chemical, biological, and environmental properties of their respective pesticides. Also recommended is continued Federal support of basic research to evaluate pesticides and their effects on soil productivity and development of a more accurate soil test on which to base rate recommendations.

Both the *Needs Assessment* and the *FY 1985 Priorities Report* neglected to discuss the issue of pesticide effects on soil fertility and near-term alternatives on pesticide regulation. Attention might be given to this area so as possibly to prevent another recall of a pesticide in wide use, such as the "EDB cancellation". The Joint Council could focus on pesticide use relative to sustaining soil productivity when preparing its next annual priorities report. The research and extension system might try to anticipate additional restrictions by moving to find alternatives to increased pesticide use.

The Agricultural Research Service allocated $550,000 of its fiscal year 1985 research budget request to focus on effects of pesticide use on soil fertility. This is an initial step to increase research on soil fertility. Additional Federal funding has been recommended to sustain and increase research on biocontrol programs and soil-plant-nutrition relationships, so that soil fertility and its management are better understood.

3/ U.S. Department of Agriculture. FY85 Priorities for Research, Extension and Higher Education. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., June, 1983. 37 p.

4/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of the Department of Agriculture and Joint Council Planning and Priority Setting Processes. Hearings, 98th Cong., 2d Sess., June 7, 1984. Hearings Transcript. p. 204.

INTEGRATED PEST MANAGEMENT PROSPECTS AND NEEDS FOR THE FUTURE

Issue

Pests cause large decreases in expected annual yields of the world's food crops even though large amounts of pesticides are used for their control. Pests of all types manage to destroy about 30 percent of the harvest worldwide each year. By using all methods of pest suppression in an integrated and ecologically compatible manner, losses to harvests can be substantially reduced. Better research and administration may be necessary to achieve such a goal.

Background

In the past, farmers have relied extensively on chemical pesticides. But these often have had deleterious side-effects on the environment and human health, and some pest species have built up a tolerance to their effects. It has been estimated that recent increases in costs for pesticides can make the price for conducting chemical warfare on pests equal to the value of the produce saved. Donald G. Crosby, a toxicologist at the University of California, sees integrated pest management (IPM) as the coming approach in pest control, with chemical pesticides "fading". 1/

Integrated pest management is a system which substitutes detailed knowledge about pests' natures and habits for indiscriminate use of chemical poisons. Integrated control uses cultural, chemical, and biological control methods to suppress pests while preserving insect parasites and predators. This is a major point that separates integrated control from chemical control. Preliminary data suggest that biological control programs return about $30 in effective crop protection for every dollar invested. In contrast, pesticide control programs return $4 to $5 in crop protection for every dollar invested. 2/

Economic analysis is used widely in IPM research to demonstrate its cost/benefit ratio. Results have shown, for instance, that:

(1) net returns to an individual cotton farmer may be increased from $25 to more than $100 per acre through the use of IPM;

1/ Salisbury, David F. New Technology Pushes American Agriculture to New Frontiers. The Christian Science Monitor. Nov. 2, 1983: 20-21.

2/ Risch, Stephen. University of California, Berkeley. Economics of Biological Control. Speech presented at the Annual Meeting of American Association for the Advancement of Science, New York, May 24-29, 1984.

(2) the net returns to alfafa producers may be increased by as much as $25 per acre and insecticide use reduced by 75 percent; and

(3) IPM methods may increase the life of alfalfa stands.

Some contend that IPM is not effective for large-scale commercial farming. However, in terms of environmental quality and savings to farmers, recent Department of Agriculture statistics show that, with use of IPM, from 1971 to 1982, insecticide use on cotton has been reduced from 73.4 million to 16.9 million pounds, on grain sorghum from 5.7 to 2.5 million pounds; and on peanuts from 6.0 to 1.0 million pounds. Such data show that IPM can minimize the use of insecticides and that IPM may be used on a large scale.

Analysis

Despite IPM's success in reducing pesticide use on some crops, it does not have universal appeal. Farmers have not accepted widely a system that does not use chemicals. Possible exceptions are those involving organic farming. Sylvan Wittwer, former Director of the Michigan Agricultural Experiment Station, testified that, because of funding constraints and the lack of multidisciplinary research necessary to improve the application of IPM, IPM will not be adopted on a large scale in this generation. 3/

Federal funding for IPM research has been the impetus for encouraging universities to overcome institutional and disciplinary barriers. But, the Department of Agriculture (USDA) has proposed terminating grants earmarked for IPM research in recent years. A Cooperative State Research Service special grant for biological pest control was terminated in the fiscal year 1985 budget that came out of USDA; the funds for IPM in both the Federal extension service and in the special grants programs were omitted, but later reinstated. IPM research is faced with increasing budget constraints.

A void noted in the Needs Assessment for Food and Agricultural Sciences is the lack of attention given to understanding the effect of pesticide use on long-term soil fertility as a major needs area. 4/ Reducing or eliminating pesticides for many users promises to help reduce farmers' production costs and maintain environmental quality. These advantages alone of the IPM model warrant considering increased Federal funding.

3/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Hearings Charter. Pesticide Use, 98th Cong., 2d Sess., Washington (unpublished).

4/ U.S. Department of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Science, Washington, U.S. Govt. Print. Off., Jan. 1984. p. 309.

Some provision might be made in USDA, in the Environmental Protection Agency, or in the National Science Foundation for the funding of large consortium projects where universities can conduct research requiring large multidisciplinary resources not available in any single institution. Such projects would integrate the various components of crop protection, crop rotation, pest-resistant varieties, biological control, and insecticide treatments into unified integrated management systems designed to minimize the use of chemicals. One such consortium has been in operation since 1980, but will be terminated early next year. Recommendations were made during the Committee on Agriculture's hearings in June 1984, that Federal funding be appropriated to continue these projects.

THE MISSION AND CLIENTELE OF THE EXTENSION SERVICE

Issue

The cooperative extension service has sought new audiences and expanded into new and more socially oriented programs from its original focus on agriculture and home economics in primarily rural areas. As demands for its services have increased in the current atmosphere of budget tightening, disagreements have arisen over what its mission and clientele should be.

Background

According to the purposes specified in the original Smith-Lever Act, the mission of the cooperative extension service is to disseminate and encourage the application of useful and practical information relating to agriculture, home economics, and related subjects among persons not enrolled in land-grant colleges. In more recent times, extension has stated its mission is to disseminate and encourage the application of research generated knowledge and leadership techniques to improve American agriculture and strengthen the nation's families and communities. Warner and Christenson, in their study of the extension service, observe that extension has defined its role as educator, even though the subject matter and audiences have changed over time. 1/

The economic and social structure of the United States has changed drastically in the last 75 years. Farmers now account for less than 4 percent of the population. Approximately 125,000 farms produce half of the value of total farm production. Farmers and their hired workers make up only 13 percent of all persons in the food and fiber system, and farming contributes only 12 percent of the value of these products at the consumer level. All of these changes, as well as many other concerns, raise the question of who should be' served by the extension service, as well as by the USDA/Land-Grant College system as a whole. In fact, two-thirds of extension's clientele live in metropolitan areas. Warner and Christenson found in their study that over a quarter of the U.S. population (22 million households) have at one time or another made use of extension's services.

Extension programing has been driven by clientele demands. Over the years, many new programs have been added and new clientele reached, often without the accompanying elimination of existing programs or clients. Extension's responsiveness to locally defined needs has been seen as a unique characteristic that is often missing from most other governmental organizations. The Extension in the '80s report argues for a broad flexible statement of purpose that can remain relevant and respond to the dynamics of change. 2/ In contrast, the

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1/ Warner, Paul D. and James A. Christenson. The Cooperative Extension Service: A National Assessment. Boulder, Westview Press, 1984. 195 p.

2/ Joint USDA-NASULGC Committee on the Future of Cooperative Extension. Extension in the '80s. Madison, University of Wisconsin-Extension, 1983. 28 p.

National Agricultural Research and Extension Users Advisory Board has called for Extension to redirect or eliminate programs and to shift personnel so they directly serve the needs of producers of U.S. food and fiber. 3/

Extension may stake out a larger role working with small and medium size farms by default. The 100,000 largest farms that produce half of total farm output have access to information sources beyond the county agent. Many of the emerging biotechnologies and communication/information technologies will be applicable mostly to large, integrated farming operations. Yet 80 percent of all farms can generally be described as small, part time, retirement, or hobby farms. With part time farming becoming the norm rather than the exception, many farm operators are pursuing goals other than that of obtaining maximum production from their farms. Some critics have suggested that extension can provide alternatives to the "bigger is better" syndrome and help stabilize the farm sector by teaching financial management and cost reduction techniques to small and medium sized farms.

Policy Questions

The fundamental question facing the Federal, State and local partners of the cooperative extension system is: Who shall be served and how?

Should the extension service mission be broadly based or narrowly focused? Should its clients be primarily rural or urban, farm or nonfarm? Should the composition of extension's clientele be left to that which results from voluntary participation in its programs?

Is an extension program which is driven by client demands always consistent with public policy? What kinds of extension programs would encourage a diverse and profitable agricultural production sector? What kinds of extension programs would encourage the use of alternatives to chemical pesticides for the control of diseases, insects, and other pests on farms and in households? Should these types of programs have a high priority?

3/ National Agricultural Research and Extension Users Advisory Board. Agricultural Research, Extension and Education Recommendations. Washington, U.S. Department of Agriculture, 1982. 30 p.

REVISING THE SMITH-LEVER FORMULA UNDER WHICH FEDERAL FUNDS ARE ALLOCATED TO STATES

Issue

The 1962 amendments to the Smith-Lever Act define the basic formula under which Federal funds are presently allocated among the States for extension work. Critics point out that the formula does not reflect extension's current mission and clientele. Can the formula be revised to provide a more equitable distribution of funds? Would a formula change improve the political support for extension funding?

Background

Cooperative extension programs receive funds from four sources — Federal appropriations, State appropriations, county or city appropriations and contributions from non-governmental sources. Over the 65 year history of the program, the ratio of funding coming from Federal-State-local sources approximates 40-40-20 respectively.

Federal funding for cooperative extension work in the States was first authorized under the Smith-Lever Act of 1914. The initial 1914 allotments were subsequently increased by nine separate pieces of legislation, before they were consolidated in the Smith-Lever amendments of 1953. These were further amended in 1955 and 1962. The 1962 amendments provide the basic formula funding (often referred to as sections 3b and 3c) and additional specific program funding (often referred to as 3d) with individual formulas appropriate to the programs. The current 3c formula divides 20 percent of the Federal payment among the States in equal shares, 40 percent among the States on the basis of rural population, and 40 percent among the States on the basis of farm population.

Criticism of the current formula centers around charges that it does not reflect extension's broadened clientele, nor extension's special mission to work with commercial farmers. At the present time, the greater number of extension's clients are urban persons, although extension still serves a larger proportion of the rural population.

A report of a joint USDA-NASULGC committee, issued in 1983, recommended that the cooperative extension partners reexamine the formula for allocating Federal funds to the States. 1/ This recommendation, in effect, endorsed a task force appointed in 1982 by the Extension Committee on Organizational Policy (ECOP) to review the manner in which funds are allocated to the States. The task force recommended, and ECOP accepted, 5 guidelines for any statutory revision of the formula:

-- Current 3b and 3c funding levels for each state sould be "grandfathered" to minimize program disruptions.

1/ Joint USDA-NASULGC Committee on the Future of Cooperative Extension. Extension in the '80s. Madison, University of Wisconsin-Extension, 1983. 28 p.

- The current 4 percent set-aside for Federal administration should be maintained.
- Maintain equal distribution of 20 percent of formula funding among the States.
- Appropriately recognize total population and agriculture (broadly defined).
- Provide earmarking of funds for innovative and multi-state efforts.

Twenty formulas were evaluated by the task force before arriving at its final recommendation. 2/ The recommendations that ECOP accepted in November 1983 included:

- Existing 3c funds, including retirement and penalty mail funds, should be shifted to 3b and such funds allocated to the States at the level received in 1985 (a "grandfather" clause).
- The Smith-Lever Act should be amended to allow Congress at any time to shift 3d funds to 3b with the allocation to each State henceforth equal to that received the year of the shift.
- The Smith-Lever Act should be amended to distribute any new 3c formula funds after 1985, net a 4 percent deduction for federal administration, as follows:
  - A. 5 percent to a State or group of States for special projects;
  - B. 20 percent in equal portions (now 20 percent);
  - C. 15 percent according to cash farm receipts (new element);
  - D. 25 percent according to farm population (now 40 percent);
  - E. 25 percent according to rural population (now 40 percent);
  - F. 10 percent according to total population (new element).
- The data used to calculate distribution of 3c funds should be updated at such times as new data are available for all factors. It is anticipated this will continue to be approximately every 10 years when new census data are released.
- The factor used to represent cash farm receipts should be a 10 year rolling average of annual cash farm receipts for each State.

An evaluation of this formula reveals that four States would receive an increase of more than 20 percent out of each new 3c formula dollar: California, Arizona, Florida, and Colorado. Six States or territories would receive a decrease of more than 10 percent from each additional funding dollar: Kentucky, West Virginia, Tennessee, Puerto Rico, Virginia, and North Carolina.

These final recommendations were circulated to all State extension directors for discussion. Reports indicated that State directors were about equally divided in their support of the existing formula versus the recommended modification. As a result the consensus of ECOP was that there is not sufficient reason to press for a change in the formula at this time.

2/ Wadsworth, Henry A. Statement before the Subcommittee on Department Operations, Research and Foreign Agriculture, Committee on Agriculture, House, U.S. Congress. Washington, June 12, 1984. 10 p.

If Federal extension funding was growing in real terms, there might be greater support for a formula change. However 3b and 3c funds have declined by one-fifth, in real dollars, over the past decade. This trend has contributed to a decline in the Federal funding share from 39 percent to 34 percent of the total extension funds. In addition, the project earmarked part (3d) of the Federal contribution has risen from 5 percent in 1970 to one-third at present.

Policy Questions

A review of the current Smith-Lever 3c formula would include the following policy questions:

(1) What criteria should be used to allocate Federal funds among the States, and what weights should be given to each of these factors?
(2) Should all of the client groups served by extension and all of extension's special missions be represented in the formula?
(3) Would inclusion of total population in the formula excessively dilute support for extension's original and primary clientele - farm people?
(4) Is farm cash receipts the best formula proxy for the number of commercial farms in a State?
(5) In light of the slow growth in federal funding for extension, would a revised formula which "grandfathers" the existing State allocations accomplish its intended objectives?
(6) Would a change in the formula encourage states that receive an increased federal allocation to reduce the level of state support?

EVALUATION OF EXTENSION EDUCATION PROGRAMS

Issue

Improved performance and impact measurement is needed to determine whether extension programs are effective, how they might be improved, and how programs compare with each other in terms of costs and benefits.

Background

Stated in simple words, an evaluation is basically a judgment of worth-- an appraisal of value. Dr. James Nichols, Dean of the College of Agriculture and Life Sciences at Virginia Polytechnic Institute, has stated that extension programing is driven by clientele demands--the toughest reviewers possible. 1/ Yet a 1981 General Accounting Office (GAO) study pointed out that the extension community recognized the need to improve program accountability and evaluation. 2/ This concern was echoed in the Extension in the '80s report: "Because evaluation is important to extension's effectiveness, we encourage all states to allocate adequate resources for developing improved evaluation methods." 3/ The report went on to recommend that extension involve the public and decision makers in its evaluation efforts.

Traditionally, evaluation of extension programs has been concerned with measuring inputs (meetings, office visits, telephone calls, etc.), counting numbers of participants, and receiving informal feedback as to clientele satisfaction. The assumption seems to have been that if programs are carried out and people are reached, then the program is effective. Suddenly in 1977, Congress ordered the Secretary of Agriculture to carry out "an evaluation of the economic and social consequences of the programs of the extension service" and to transmit a report of the evaluation to the Congress not later than March 31, 1979 (Section 1459, P.L. 95-113, Sept. 29, 1977).

The 1981 GAO report also questioned extension's program accountability and evaluation efforts. GAO found that 33 of the State extension services had not assigned specific evaluation responsibilities to any particular staff. Twenty-one other State or territorial extension service had staff that included some evaluation responsibilities, but only five had separate evaluation units. The report pointed out that clearly stated and meaningful program

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1/ Nichols, James. Statement before the Subcommittee on Department Operations, Research and Foreign Agriculture, Committee on Agriculture, House, U.S. Congress. Washington, June 7, 1984. 8 p.

2/ U.S. General Accounting Office. Cooperative Extension Services's Mission and Federal Role Need Congressional Clarification; Report to the Congress by the Comptroller General of the United States. CED-81-119, August 21, 1981. Washington, 1981. 49 p.

3/ Joint USDA-NASULGC Committee on the Future of Cooperative Extension. Extension in the '80s. Madison, University of Wisconsin-Extension, 1983. 28 p.

objectives and evaluation criteria are essential before program evaluation can take place. GAO concluded that the major obstacle to achieving this was the absence of a responsible central office to clearly define accountability and evaluation standards for the entire extension system.

The nationwide accountability and evaluation system implemented throughout the cooperative extension system on October 1, 1983, was described in testimony before the Subcommittee on June 13, 1984. 3/ Key ingredients of the system are a 4-year planning cycle, improved reporting procedures, and increased evaluation at both the State and Federal levels. The 4-year plans of work in each state focus on major program efforts, including objectives and projected impacts. The system also links reports of program accomplishments to projected programs of work. Five national evaluation studies have been implemented for educational programs in integrated pest management, renewable natural resources, financial planning and management, volunteerism, and leadership development. In addition, States have, or will be initiating, more than 200 program evaluation studies.

Policy Questions

The new accountability and evaluation system is a promising tool, but it will not answer the fundamental policy questions concerning extension's appropriate mission and target audiences. The precise role of the U.S. Department of Agriculture in providing overall leadership and guidance for planning and evaluating extension activities is still not clear. What has been the Federal role in reviewing the 4-year State plans?

The initial evaluation studies will focus primarily on identifying program impacts, rather than opportunities to improve programs. Ongoing evaluation studies may not directly affect resource allocation decisions, since there is no attempt to directly compare costs and benefits of different programs. What progress has been made in establishing the costs and benefits of major extension programs? Will comparisons among evaluations be difficult due to the diversity of evaluation formats being used?

3/ Greenwood, Mary Nell. Statement before the Subcommittee on Department Operations, Research, and Foreign Agriculture, Committee on Agriculture, House, U.S. Congress. Washington, June 13, 1984. 6 p.

IMPROVED COORDINATION BETWEEN THE TEACHING, RESEARCH, AND EXTENSION SYSTEMS

Issue

How might program planning and implementation be more closely coordinated between the cooperative extension system (at the Federal, State and local levels), the higher education program of the colleges of agriculture, the State agricultural experiment stations, and the USDA's inhouse research programs?

Background

The mission of the agricultural research system is to produce the new knowledge and technology required to assure the continuing vitality of the food and agricultural industry. Research results must be put in the hands of those who need them; this task is the responsibility of the cooperative extension service. Our nation's colleges and universities provide the educational programs that train the scientists and other professionals needed to staff these programs.

In many ways extension is in the unique position to serve as a communication link among each of the other systems and their respective clienteles. Although the Office of Higher Education Programs in the Agricultural Research Service (ARS) sponsors a variety of projects with colleges of agriculture to improve their program quality and enrollment, the extension service, in its 4-H program for both rural and urban youth, can increase awareness of opportunities for scientists and professionals in agriculture. Although ARS has appointed a full time technology transfer coordinator and has instituted a computer network to speed research results to Federal extension specialists and extension workers in all 50 States, the extension service can serve as an early warning system by identifying emerging problems and advising appropriate researchers.

The 1981 farm bill (P.L. 97-98, Sect. 1405) required the Department of Agriculture to conduct a long-term needs assessment for food, fiber, and forest products, and to determine the research needed to meet the identified needs. Section 1407 of that Act requires the Department to develop an annual research priorities report based on research needs. In February of 1983, ARS issued a longterm strategic plan 1/ and a 6-year program implementation plan 2/ that are intended to set the agency's future research priorities. These documents provide important information to organizations that cooperate with ARS, use ARS research findings or provide resources for ARS activities, but whether or not these organizations make use of the information in their own program planning is at present left to their individual initiative.

1/ U.S. Department of Agriculture. Agricultural Research Service. Agricultural Research Service Program Plan. Washington, Dept. of Agriculture, 1983. 73p. (U.S. Dept. of Agriculture. Misc. Pub. No. 1429)

2/ U.S. Department of Agriculture. Agricultural Research Service. 6-Year Implementation Plan, 1984-1990. Washington, Dept. of Agriculture, 1983. 34p.

Policy Questions

Is the cooperative extension service using the ARS program plan and 6-year implementation plan in developing its own staffing and program plan?

What plans has the cooperative extension service made to make maximum use of the ARS technology transfer plan? Will the ARS-ES technology transfer computer network be accessible to farmers through State or county extension computer networks? Will the ARS-ES technology transfer computer network be a two-way communication channel that can be used by extension to advise researchers of emerging problems? Is there value to including other USDA in-house research agencies in the technology transfer computer network?

How can the cooperative extension service coordinate its youth program with the ARS/Land-grant College efforts to increase enrollment in agricultural college curricula?

THE IMPACT OF ELECTRONIC INFORMATION TECHNOLOGY ON THE EXTENSION SERVICE

Issue

Successful management of agricultural operations in the future will require sophisticated decision aids and rapid access to information bases. Computer technology offers exciting opportunities to provide farmers with these services. The computer age will fundamentally transform extension staffing patterns, county program emphasis and clientele reached by county extension workers. What are the proper roles for the cooperative extension service and the private sector in providing computer services to farmers?

Background

"The personal computer may represent the best near-term tool to asisting both limited resource farmers as well as large producers in improving their margins. We believe that the county extension agent and the extension specialists are well situated to develop the database which would show limited resource famers the appropriate management practices for his crops or livestock." This challenge was offered by Dr. William Marshall, Chairman of the National Agricultural Research and Extension Users Advisory Board, in testimony before the Subcommittee on Departmental Operations, Research, and Foreign Agriculture of the House Committee on Agriculture on June 7, 1984. The response was quick in coming from Dr. Henry Wadsworth, Chairman of the Extension Committee on Organization and Policy (ECOP), who in testimony before the same Subcommittee on June 12, 1984 stated: "There is widespread recognition among the states that we could better serve existing audiences and reach new ones by increasing our utilization of existing electronic technologies, particularly computers and video systems."

The land-grant universities and the cooperative extension service have had a long history of rapid adoption of information technology to enhance their operating efficiency and educational effectiveness. As Dr. Wadsworth's testimony pointed out, the land-grant universities also recognize the vital contribution of the private sector in information delivery. ECOP policy is that land-grant universities should cooperate with private sector information delivery systems and not directly duplicate services available in the private sector.

State-wide extension computer networks exist in about one-fourth of the States. Other States have some computer capability, but lack linkage to all counties. State extension services have faced problems in selecting and retaining state-of-the-art computing equipment because of rapid changes within the industry. In addition, States with networking capability have found that more dollars are required to maintain a state-of-the-art network, train staff and develop software, than is required in the initial hardware purchase.

Dr. Wadsworth believes that the State experiment stations and the extension services of each State should assume the responsibility of translating research and information into software packages applicable to family farms and related production and marketing institutions. But Dr. Marshall indicated that the private sector is not depending on the extension service for prototype software. His position is that the skills required to develop software lie principally in the private sector, while the skill absent in the private sector is the skill of on-farm teaching. He therefore advocates that extension should develop its skills in the area of use of the personal computer.

Most knowledgeable persons agree that existing hardware and software needs to be adapted to meet local agricultural needs. A close relationship between the private sector and public sector research and extension is needed to assure that computer models and other decision aids are converted to "user friendly" software and delivered to agricultural producers.

It is still unclear what the role of extension will be in the development of software and the operation of videotex systems for farmers. No doubt the role will vary by State. There will be a period of overlap among the States and with the private sector. In the long run the role of the county agent will change as people learn to access regional and national information services. The county agent's ultimate role may become one of providing specialized local information and service to noncomputerized clientele.

Policy Questions

As extension and the farm sector move into the the computer era an number of policy question arise.

— How can extension encourage the adoption of this new technology without competing with and discouraging the full participation of the private sector?
— How can separate State extension services avoid unnecessary duplication of effort in the development of information bases?
-- How can problems of hardware incompatability between State extension systems or between county extension and county USDA offices be minimized?
-- Can extension assure that limited resource rural residents will not be bypassed by new electronic information systems?

THE QUALITY OF FOOD AND AGRICULTURAL SCIENCES EDUCATION

Issue

Several witnesses at the Committee on Agriculture's February 1984, hearings testified that high-caliber faculties, better quality curriculum programs, and more modern teaching facilities were necessities in the food and agricultural sciences at U.S. colleges and universities. "Colleges of agriculture must assume the primary responsibility for the quality of its student body, the relevance and currency of its curricula, [and] the competence of its faculty," according to James Nichols, Council of Administrative Heads of Agriculture, National Association of State Universities and Land Grant Colleges, and Dean, College of Agricultural and Life Sciences, Virginia Polytechnic Institute and State University. 1/ Testimony suggested that the role of the Federal Government, as a partner with the States and the private sector must be enhanced, and that the Federal Government should become a stronger national advocate for higher education in the food and agricultural sciences.

Background

Preserving high-level faculty members at the undergraduate, and particularly, the graduate level in the food and agricultural sciences is a major concern in both public and private agricultural sectors. Many qualified food and agricultural science faculty are leaving the universities for employment in agricultural industries because of higher salaries and better research facilities.

An agricultural curriculum renewal program is currently underway at some land grant and non-land grant colleges. A Curriculum Evaluation Task Force composed of agricultural deans and directors of resident instruction suggested 12 areas of study that were subsequently discussed by seven food industry executives. 2/ The food executives recommended that three of the 12 areas of study be developed into courses. Development of these three areas--Ethics and Public Policy, Agricultural Systems Analysis, and Problem Solving--currently is being implemented.

It has also been reported, by the USDA Joint Council on Food and Agricultural Sciences, that instrumentation used at the undergraduate and graduate levels for food and agricultural sciences research, in the "top-ranked

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1/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Instructional Programs in the Department of Agriculture and in the Food and Agricultural Sciences in the United States. Hearings, 98th Cong., 2d Sess., Feb. 7, 1984. Hearings Transcript. p. 135.

2/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Review of Teaching Activities of the U.S. Department of Agriculture. Hearings, 98th Cong., 2d Sess., Feb. 8, 1984. Hearings Transcript. p. 8-9.

universities has a median age twice that of the instrumentation available to leading industrial research laboratories. Inadequate instrumentation severely restricts the scope and pace of advanced education in universities." 3/

Analysis

Unless some positive action is taken at food and agricultural universities, it is likely that the alleged "brain drain" from these schools will continue. Many witnesses at the Committee on Agriculture's February hearings concurred with the Secretary of Agriculture, who said that in order to alleviate this problem, "faculty development (including retraining) and inducement strategies must be augmented. Fringe benefits and incentives for qualified scientists to remain in faculty positions must be created and well articulated." 4/ To maintain a superior education program in the food and agricultural sciences, faculty needs, in terms of both salary and research opportunities, could be given higher priority in order to retain high-quality talent.

"To generate the maximum benefit from curriculum improvement," stated Joseph King, Liaison to the Resident Instruction Committee on Organization and Policy, at the February hearings, "the $5 million for graduate fellowships approved in the 1984 continuing budget resolution should be increased to $10 million. This will attract and assure the completion of formal education for many of the most fully-qualified students." Also, Dr. King recommended that "strengthening grants," which are authorized in Title XIV of P.L. 97-98 (the Food and Agricultural Act of 1981), to strengthen the ability of institutions to respond to "State, national, or international educational needs in the food and agricultural sciences," be funded by the USDA to ensure curriculum improvement.

Equipment and instrumentation needs are alleged to be critical in colleges and universities in the food and agricultural sciences fields. Replacing and upgrading outdated equipment and instrumentation is generally the solution to the problem. Some pieces of equipment, however, are so expensive that another recommendation is to set up regional or centralized laboratories available to food and agricultural students of more than one university. 5/

3/ U.S. Department of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., Jan. 1984. p. 310.

4/ U.S. Department of Agriculture. Summary: Needs Assessment for the Food and Agricultural Sciences; A Report to the Congress from the Secretary of Agriculture. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., Jan. 1984. p. 53.

5/ U.S. Department of Agriculture. Five-Year Plan for the Food and Agricultural Sciences: A Report to the Secretary of Agriculture. The Joint Council on Food and Agricultural Sciences. Washington, Feb. 1984. p. 78.

Some additional questions are: Can "strengthening grants" be used for improving equipment, instrumentation, and research facilities at academic institutions? Would a three-partner effort between agricultural industries, academia, and the Federal Government provide needed resources so that "mid-career" retraining of agricultural college faculty could be made available? In addition, would such a partnership erase agricultural college faculty salary inequities, as well as, improve deteriorating research facilities, equipment, and instrumentation?

USE OF INFORMATION SYSTEMS IN HIGHER EDUCATION FOR THE FOOD AND AGRICULTURAL SCIENCES

Issue

It has been recommended that an information system be developed to provide data on all aspects of the supply and demand of manpower in the food and agricultural sciences. Currently, a comprehensive information system of this nature does not exist. Several witnesses identified the need for such a system, even though there are other available national data bases that contain statistics relevant to higher education in the food and agricultural sciences. More attention may need to be given to funding a system already being developed, the Food and Agricultural Education Information System (FAEIS).

Background

Detailed national data on manpower supply in such scientific disciplines as engineering, the physical sciences, mathematical sciences, and medicine are available through various Federal agency and private data bases and information systems. Comparable information systems for the food and agricultural sciences, however, have not been developed. According to Dwayne Suter, Associate Dean of the College of Agriculture at Texas A&M University, who testified at recent hearings, [1] data are not compiled that are pertinent specifically to scientific and professional expertise in the food and agricultural sciences. Also, existing Federal and private data bases (such as those maintained by the National Science Foundation and the National Association of State University and Land Grant Colleges), that include some information about food and agricultural sciences, also are often incompatible for comparative purposes. In addition, he testified that, many kinds of important data related to the food and agricultural sciences are not collected and included in the currently available on-going systems.

According to Suter "one of the ways whereby the Office of Higher Education Programs of the USDA is endeavoring to assist higher education institutions in strengthening their academic programs in the food and agricultural sciences is through the development of a comprehensive national information system which will provide ready access to empirical data essential to improved program planning, coordination, administration, and evaluation. The information system being developed will be known as the Food and Agricultural Education Information System (FAEIS)." [2]

FAEIS is being developed jointly by a nine member panel composed of food and agricultural sciences representatives from professional and scientific associations, university administrators, and individuals from the USDA Office of Higher Education Programs. The system would provide data on current and

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[1] U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research and Foreign Agriculture. Higher Education in the Food and Agricultural Sciences. Hearings, 98th Cong., 2d Sess., June 12, 1984. (Unpublished testimony of Dwayne A. Suter.)

[2] Ibid.

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future "student enrollments, degrees conferred, teaching programs, attributes of faculty, graduate student support, and employment demand for graduates." 3/ It is proposed that FAEIS serve both public and private food and agricultural science schools. It is also intended, according to Dwayne Suter, to "provide more accurate, timely, comprehensive data which will be readily available to users striving to better understand/analyze" food and agricultural academic programs. In addition, FAEIS would improve "the ability of professionals to document program breadth, identify shortages of resources, justify requests for additional resources, and substantiate the Nation's need for graduates of higher education in the food and agricultural sciences." 4/

Analysis

The Federal Government, through the USDA, provides total financial support for the FAEIS project. The USDA awarded a contract of $145,000 to Texas A&M University for the initial development of FAEIS. At the present time, several issues related to developing the system have not been resolved. The rate of development and implementation of FAEIS depends on the level of Federal funding. The current annual Federal funding amount is $75,000. A larger funding allocation might be necessary to enhance the rate of development and implementation of the system.

Currently, it is unknown how FAEIS will be financially maintained once the project is completed. Will the private sector take on these responsibilities of maintaining the system, or will the funding effort be combined to include the Federal Government, academia, and private sector agricultural firms?

3/ Ibid.

4/ Ibid.

SUPPLY OF AND DEMAND FOR AGRICULTURAL SCIENTISTS AND TECHNICIANS

Issue

According to the U.S. Department of Agriculture, there is a growing demand, but shortfall in supply, and consequent need for trained agricultural scientists and technicians throughout the agricultural sector. 1/ Colleges and universities are experiencing declines in undergraduate enrollments in agricultural fields, in the number of agricultural graduates, including doctoral level graduates, and in trained faculty members. In order to meet current and projected demands for food and agricultural manpower, there seems to be a need to improve opportunities for training agricultural professionals and skilled technicians in both the public and private sectors.

Background

"If the United States is to continue as the lead Nation in confronting problems associated with increasing global population and decreasing agricultural and natural resources," K. Jane Coulter and Marge Stanton stated in a 1980 USDA report, "it must possess the requisite 'human capital'--individuals with higher education in the food and agricultural sciences." 2/

Coulter and Stanton reported that when projected estimates of supply and demand in the food and agricultural sciences through 1985 were compared in eight occupational areas investigated, shortages of qualified graduates seemed to exist in five of those areas--Scientific and Professional Specialists, Manufacturing and Processing Scientists and Engineers, Sales and Service Representatives and Purchasing Agents, Administrators/Managers/Financial Advisors, and Miscellaneous Agricultural Specialists. The average annual job demand would exceed the average annual supply by 50 percent of Miscellaneous Agricultural Specialists; 30 percent for Administrators/Managers/Financial Advisors; and 18 percent for Manufacturing and Processing Scientists and Engineers. A comparison of projections for average annual number of graduates compared with the average annual number of job openings revealed that the largest manpower shortfall would occur for Miscellaneous Agricultural Specialists, Administrators/Managers/Financial Advisors, Sales and Service Representatives and Purchasing Agents, and Scientific and Professional Specialists. Collectively, there appeared to be an average annual shortage of about 8,500 qualified graduates in these occupational areas. 3/

1/ U.S. Department of Agriculture. Reference Document: Needs Assessment for the Food and Agricultural Sciences. The Joint Council on Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., Jan. 1984. p. 300.

2/ U.S. Department of Agriculture. Graduates of Higher Education in the Food and Agricultural Sciences: An Analysis of Supply/Demand Relationships. Vol. 1--Agriculture, Natural Resources, and Veterinary Medicine. Edited by Kyle Jane Coulter and Marge Stanton, Science and Education Administration, July 1980. Washington, 1980. p. 86.

3/ Ibid., p. 2.

In recent years, there has been a decrease in the number of undergraduate students enrolling in the agricultural sciences at universities. One of the reasons that might contribute to this situation is that many high school counselors do not recommend agriculture to students as a potential career. The image of agriculture as a scientific area does not seem to be recognized as such by many high school counselors, science teachers, parents, or students. In addition, the percentage of college age youth in the 18 to 24 year-old age range is declining. Furthermore, "the traditional source of agricultural students has been farm and ranch populations; ironically, these populations [also] have declined . . . ." 4/ According to recent testimony by John P. H. Brand of the University of Connecticut, if undergraduate agricultural enrollments, which have decreased 20 percent in the last four years at land grant colleges, continue to decline, the pool of trained manpower in this area probably will decline. 5/

The 1980 USDA report, previously cited, found imbalances in the supply of and demand for advanced degree level graduates in the food and agricultural sciences. Specifically, it was stated that "through the mid-1980s, estimated supplies of associate and baccalaureate degree recipients appear to be adequate for most types of employment demand. Current and projected supplies of graduates with advanced degrees, "however, "do not appear to satisfy employment demand." 6/

Currently, there is a shortage of faculty trained in current methods in the agricultural sciences. 7/ According to the Department of Agriculture, most of today's agricultural faculty members received their training about 20 to 30 years ago and may need more training in order to function in the present scientific setting. Also, the Department expects "that a greater-than-average number of Ph.D. graduates will be needed as replacements during the late 1980s because of an above-average number of current faculty members that will reach retirement age." In addition, some of the qualified agricultural faculty members are leaving the university setting for jobs in agricultural industries because of inadequate salaries and promotional opportunities, as well as outdated research equipment and facilities. There is concern that unless something is

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4/ U.S. Department of Agriculture. Reference Document: Needs Assessment of the Food and Agricultural Sciences. p. 300.

5/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Agricultural Research, Extension and Higher Education. Hearings, 98th Cong., 2d Sess., June 12, 1984. Unpublished testimony, p. 2, by John P. H. Brand, Associate Dean, College of Agriculture and Natural Resources, the University of Connecticut, and Chairman, Resident Instruction Committee on Organization and Policy, Division of Agriculture, National Association of State Universities and Land Grant Colleges.

6/ U.S. Department of Agriculture. Graduates of Higher Education in the Food and Agricultural Sciences. p. xiii-xiv.

7/ U.S. Department of Agriculture. Summary: Needs Assessment for the Food and Agricultural Sciences. The Joint Council of Food and Agricultural Sciences. Washington, U.S. Govt. Print. Off., Jan. 1984. p. 52.

done to encourage qualified staff members to stay at universities, a brain drain from the agricultural colleges may occur during the next 10 years. 8/

Analysis

Various recommendations have been made for programs beginning in elementary school and continuing through graduate school, that might help to improve the image of agriculture and increase "human capital" in the food and agricultural sciences.

The Council for Agricultural Science and Technology (CAST), an organization sponsored by 26 agricultural scientific societies, is working on a plan that might alleviate the alleged bias of high school counselors against an agricultural career for students. It has been suggested that students need to be adequately exposed to the idea of agricultural sciences as an occupation as early as elementary school.

Funding at the college level was a main concern expressed at recent hearings. 9/ According to the testimony of W. Ann Reynolds, Chancellor of California State University, if more State funding were provided, agricultural programs and enrollment could be increased. Also, K.R. Tefertiller, Vice President for Agricultural Affairs, Institute of Food and Agricultural Sciences, University of Florida, stated that partly because of a lack of Federal and State funding, opportunities for agricultural careers were not properly conveyed to students.

Federal financial support, possibly, could be increased for such grant programs in the U.S. Department of Agriculture (USDA) as the Competitive Graduate Fellowship and Research Grant programs, as well as for formula funding. Policymakers might also consider encouraging the development of matching public-private student support programs. Overall, scholarships, fellowships, internships, and other such incentives might be increased in order to attract more undergraduate and graduate students to the agricultural sciences.

The USDA Competitive Graduate Fellowship program, however, is going to be phased out and replaced by the Competitive Research Grant Program that will support graduate and postdoctoral students, but will emphasize biotechnology research. In fiscal year 1984, $5 million was appropriated for the Fellowship program. Funding has not been recommended for fiscal year 1985 to continue the program.

Concern about the structure of the Competitive Research Grant program also has become evident. Because it stresses biotechnology, students in other disciplines, such as agricultural engineering or agricultural economics, may be eliminated from participating in the program.

8/ U.S. Dept. of Agriculture. Summary: Needs Assessment for the Food and Agricultural Sciences. p. 52-53.

9/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Instructional Programs in the Dept. of Agriculture and in the Food and Agricultural Sciences in the United States. Hearings, 98th Cong., 2d Sess., Feb. 7, 1984. Hearings Transcript. p. 114.

COMPETITIVE GRADUATE FELLOWSHIP GRANTS

Issue

The Competitive Graduate Fellowship Grant program, sponsored by the Agricultural Research Service of the U.S. Department of Agriculture, through its Higher Education Programs (HEP) unit, supports outstanding graduate students in the food and agricultural sciences. After fiscal year 1984, the program will be phased out. A Competitive Graduate Research Grant program, sponsored by the USDA Cooperative State Research Service, would be established in its place to support graduate and postdoctoral students, largely in biotechnology research. There is concern that the Competitive Graduate Research Grant program would not adequately replace the functions served by the Competitive Graduate Fellowship program because of the emphasis to be placed by the new program on supporting students mainly involved in biotechnology research. Recommendations have been made to continue the Competitive Graduate Fellowship Grant program.

Background

The Competitive Graduate Fellowship Grant program has supported outstanding food and agricultural sciences students in all disciplines of the food and agricultural sciences. The program was authorized in 1977 as part of Title XIV of Public Law 95-113 (The Food and Agricultural Act of 1977). For fiscal year 1984, $5 million was appropriated, which would fund about 300 graduate students for one year of study at about 30 universities. The Administration did not support continuation of this program for fiscal year 1985 because of "severe Federal funding constraints." 1/

For fiscal year 1985, $50 million has been proposed to fund competitive research grants that would support research largely in biotechnology. It is anticipated, however, that about one-fourth of the $50 million would be used for the direct support of graduate and postdoctoral students. 2/ The way the program is structured, students majoring in such areas as agricultural engineering or agricultural economics would no longer be eligible to participate in the program because these fields are not related to biotechnology. 3/

Analysis

John P. Jordan, Administrator, Cooperative State Research Service, (USDA), during testimony at recent hearings, suggested that the Competitive Graduate

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1/ U.S. Department of Agriculture. 1985 Budget Explanatory Notes for Committee on Appropriations. Vol. 1. Washington, 1984. p. 6-21.

2/ U.S. Congress. House. Committee on Agriculture. Subcommittee on Department Operations, Research, and Foreign Agriculture. Instructional Programs in the Department of Agriculture and in the Food and Agricultural Sciences in the United States. Hearings, 98th Cong., 2d Sess., Feb. 7, 1984. Hearings Transcript. p. 35.

3/ Ibid., p. 36.

Research Grant program, that would emphasize biotechnology research, is "an imaginative approach to move forward." The idea of such a program originated in a study by the "National Association of State Universities and Land Grant Colleges on emerging technologies in agriculture, policies, and issues." 4/

Despite this view, questions still remain about the need to extend the Competitive Graduate Research Grant program. Representative George Brown, Chairman of the House Agriculture Subcommittee on Department Operations, Research, and Foreign Agriculture, suggested during hearings that "the competitive graduate fellowships would have a somewhat broader application and would provide a little more opportunity to involve the whole scope of agriculture." 5/ Restoring funding for the Competitive Graduate Fellowship Grant program has been recommended by others. 6/ They reason that more support should be made available for traditionally conducted agricultural research, rather than for the basic research and biotechnology research expected to be emphasized in the competitive grants research program.

4/ Ibid., p. 40.

5/ Ibid., p. 35.

6/ This recommendation was made by W. Ann Reynolds, Chancellor, California State University, during hearings testimony before the Committee on Agriculture Subcommittee on Department Operations, Research, and Foreign Agriculture on Instructional Programs in the Department of Agriculture and in the Food and Agricultural Sciences in the United States, Feb. 7, 1984, hearings transcript, p. 107. Also, Representative George Brown, Chairman of the Subcommittee commented that he would not recommend that funding be restored to the Graduate Fellowship Program, "but it could be one way to maintain the breadth of the graduate fellowship program and include other disciplines than just biotechnology," hearing transcript, p. 36.

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